Action Biology

TEACHER'S GUIDE

Weinberg and Stoltze

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Action Biology

Stanley L. Weinberg — Herbert J. Stoltze

TEACHER'S GUIDE

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INTRODUCTION

The "Action Biology" program consists of 7 units—*Keeping Alive, Food, The Invisible World, Ecology, Doing Their Thing, Children and Ancestors,* and *Reproduction.* These units can be taught in any order.

The "Action Biology" program . . .

a. consists of short, episodic chapters to neutralize poor motivation and short attention span. Each chapter requires 1, 2, or 3 days' class time. Activities vary. Continuity is de-emphasized so that students constantly get a fresh start.

b. gives coverage to the most common areas of biology. The content is relevant and realistic.

c. emphasizes activities rather than textbook study or didactic presentation to expand opportunities for success and minimize failure. The motivation of the student is thereby increased.

d. de-emphasizes reading as a prerequisite for learning. Through science activities, the student improves his skills in reading, word usage, and mathematics.

e. is life and career oriented. Career and consumer education are interspersed throughout the program.

f. has an easy reading level with minimum technical vocabulary, and short sentences and paragraphs. Phonetic pronunciation of technical terms is provided at the beginning of each chapter.

g. stresses unsophisticated inquiry, namely, simple but careful observation, collecting and recording facts, and drawing conclusions from the activities. Flow sheet drawings lead the student step-by-step through the stages of the activity.

h. provides for evaluation in terms of behavioral performance. Questions can be answered or discussed orally, in writing, or through role-playing.

i. is visually instructive. The illustrations are an integral part of the teaching and learning process—the graphics carry the message.

j. can be used in a traditional classroom or in a self-paced individualized learning program. Most chapters within a unit can be used in any sequence.

The *Teacher's Guide* provides specific procedural directions for each chapter. However, the program may be modified in accordance with the insights of the teacher as well as prevailing school conditions. The detailed information which is provided will prove especially helpful to the less experienced teacher.

Each of the 7 units in the *Teacher's Guide* contains the following:

A Table of Contents;

A PLAN AHEAD section indicating which chapters require advance preparation;

Detailed directions, information, and suggestions for each chapter, as indicated below;

A list of Supplies and Equipment needed for the entire unit;

A list of Audiovisual Materials to supplement the student text.

Each chapter in the *Teacher's Guide* provides the following sections and subsections:

BEHAVIORAL OBJECTIVES. Listed under this heading are some of the specific, observable behaviors expected of the student during and after completion of the chapter. The teacher can use the objectives to help plan instruction. Assessment of achievement of the objectives can serve as a basis for evaluating student progress. If the objectives, which require psychomotor skills, oral responses, and written work, are deemed insufficient for precise evaluation, tests based on the behavioral objectives can be easily formulated.

TEACHING TIPS. In addition to background information and enrichment, the section presents helpful suggestions for implementing discussions, student worksheets, games, role-playing, and career exploration.

ACTIVITY. Detailed information for the activity is presented under 3 subheadings:

Materials gives a complete list of materials needed for the activity for each student or group of students.

Preparation of Materials provides directions for preparing various chemical solutions and other materials.

Notes on the Activity offers suggestions for organizing and developing the activity. Alternative procedures and ways of handling expected student responses or problems are also provided.

WORKSHEET. All worksheet answers are provided.

ANSWERS TO QUESTIONS. Questions within the text are answered in this section. Often no exact answers can be given.

The names and addresses of distributors of audiovisual materials and science supply houses are provided at the back of the *Teacher's Guide.* Blackline masters for the more involved worksheets are also provided in the back of the *Teacher's Guide.*

We are in a transition period designed to lead in the near future to widespread adoption of the metric system. For this reason, "Action Biology" gives dimensions in both metric and English units. It is suggested that students be provided with metric rulers, and as far as possible measurements be metric.

KEEPING ALIVE

CONTENTS

PLAN AHEAD for the following lessons:

Chapter
1 Obtain blood-staining kits and sterile lancets.
3 Obtain sterile lancets.
4 Prepare solutions.
5 Prepare blood slide unknowns.
6 Obtain rubber bulbs and set up apparatus for activities.
7 Obtain goldfish, set up aquarium, obtain oil of wintergreen (methyl salicylate), prepare anesthetic, and prepare half slides.
8 Obtain calf or sheep heart.
9 Duplicate copies of Chart of Circulation and prepare credit slips.
11 Obtain oral thermometers.
12 Order cow or sheep lungs with windpipe attached (pluck) from the butcher. Construct bell jar model respiratory system and spirometer.
13 Prepare phenolphthalein and sodium hydroxide solutions.
14 Prepare practice urine. Obtain a fresh kidney. Duplicate copies of URINALYSIS WORKSHEET.
15 Collect classified advertising sections from your local newspaper. Make contact with health career resource persons.

1 STAINING BLOOD Pages (3) 3 - (8) 8

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. state several characteristics of blood.
b. state the function of blood plasma.
c. obtain a blood sample from finger using aseptic procedure.
d. prepare a blood smear.

TEACHING TIPS

1. The subject of blood fascinates students. The first page of the chapter introduces the subject by referring to information which students already possess.
2. Illustrate Section A by exhibiting a bag of expired blood from a blood bank. If the bag is allowed to stand, the cells will settle to the bottom and the yellow plasma will form a layer on top.
3. As enrichment, have a laboratory technician talk to the class. Or, take the class to visit a hospital's blood bank.

DRAWING-BLOOD ACTIVITY

Materials (per student)

soap
absorbent cotton balls
70% alcohol
disposable sterile lancet
3 slides
droppers
beaker
table salt
toothpicks
marker
paper towels

Preparation of Materials

1. To prepare 70% alcohol, mix 25 ml of water with 70 ml 95% alcohol. If ethyl alcohol is not available, use isopropyl alcohol (rubbing alcohol).
2. Baby food jars are an economical substitute for beakers.
3. Kits containing all necessary materials are available from biological or hospital supply houses.

Notes on the Activity

1. CAUTION: All parts of the activities should be done under a teacher's supervision. Teachers should follow any special procedures required by their school district.
2. The technique for drawing blood safely, once acquired in this activity, will be used in other blood activities in this book and in "Action Biology," *Children and Ancestors.*
3. Before students draw any blood themselves, demonstrate the entire technique, including how to unseal a lancet in Step F without touching the point. Caution students to follow directions exactly. If students are reluctant to draw their own blood, let them use somebody else's—perhaps yours.
4. In Step E dry finger with sterile cotton, or air dry it.
5. In Step F *warn students to use a lancet only once and then throw it away.*
6. To lessen the chance of fainting in Step G, students should be seated when performing a puncture. Puncturing is easiest when the puncture is made parallel to the ridge lines in the fingerprint.
7. The slide prepared in Steps H through L will be used in *Keeping Alive,* Chapter 5.
8. To make a good smear in Steps M through P, the slides must be perfectly clean. Wash slides thoroughly in soap and water, rinse well, and dry. Handle the clean slides only by the edges.
9. In Step P students will tend to use the spreader to pull the blood rather than push it. Watch and correct them.
10. Students should work in pairs. While 1 student is mixing blood, salt, and water, Steps I to L, the second student can prepare the blood smear, Steps M to P.

STAINING-BLOOD-CELLS ACTIVITY

Materials (per group of 10)

blood smears from Drawing-Blood Activity
blood-staining kit
dropper bottle of 70% methyl alcohol
dissecting needle
paper towels
forceps

(per pair of students)

microscope
microscope lamp
lens tissue

Preparation of Materials

1. Blood smear stains and kits can be purchased from biological supply houses. The authors have had much success with Scientific Products Differential Stain Kit (Order B 4135-Kit). This inexpensive, simple to use kit consists of bottles of blue and red stain, a dropper bottle for methyl alcohol (alcohol not included), a stand, and directions for use. See Directory of Science Supply Houses for address.
2. If your school district does not permit students to draw blood, kits containing

resuspended cells may be obtained from Kemtec Educational Corp.

3. The 70% methyl alcohol must be used as a fixative in Step B.

Notes on the Activity

1. If time permits, students can examine their smears. The microscope activities in "Action Biology," *The Invisible World,* Chapters 1 and 2, are necessary preparation for this activity.
2. Demonstrate how to stain a blood smear.
3. The blood smear must be absolutely dry before it can be stained. Damp smears may be fanned to hasten drying.
4. Caution students that the stains can ruin their clothing.
5. In Step E, if there are not enough water taps available in the room, rinse slides in jars of water.
6. Forceps may be used to dip the slides into the jars of stain.

ANSWERS TO QUESTIONS

1. Red. No.
2. Warm. Blood carries heat to all the parts of the body.
3. Liquid, but the cells are solid.

2 LOOKING AT BLOOD CELLS Pages (9) 9 - (12) 12

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. examine a blood smear with a microscope and identify red blood cells, white blood cells, and platelets.
b. state the function of red blood cells, white blood cells, platelets, and hemoglobin.
c. describe some of the routine tasks performed with blood by a lab technician.
d. state the relative number of red blood cells, white blood cells, and platelets in a drop of blood.
e. solve simple blood count problems.
f. describe the causes of anemia and leukemia.

TEACHING TIPS

1. Materials needed to examine blood cells are a microscope, a microscope lamp, lens tissue, and a well-stained blood smear. To review or teach students how to use the microscope see "Action Biology," *The Invisible World,* Chapters 1 and 2.
2. As mentioned in Section B, students may find 5 different types of white cells. All have large nuclei of distinctive shapes. The white cells can also be told apart by the following characteristics:

Neutrophils—most numerous; lavender granules
Eosinophils—pink granules
Basophils—rarest; large blue granules
Lymphocytes—round nuclei, no granules, narrow zone of bluish cytoplasm
Monocytes—horseshoe-shaped nuclei, no granules, wide zone of bluish cytoplasm

Illustrative charts will help in identifying the 5 types. Without using specific names, encourage students to find the 5 types under the microscope. Give a small reward to any student who finds a basophil—you will not have to give many rewards.

3. In discussing Section C demonstrate the use of a hemocytometer.
4. Section D constitutes a summary of the lesson. Divide the class into small groups and have each group discuss the 8 terms listed. Groups may submit their answers in writing. Part D may also be answered in a class discussion or as an individual written assignment.

BLOOD COUNT WORKSHEET

1. He has anemia. He has too few red blood cells. His body is starved for oxygen.
2. The lab technician can count the number of red blood cells or measure the amount of hemoglobin in the cells.
3. The high white cell count indicates that her body is fighting the infection.
4. The patient is in danger of not being able to fight off an infection because of the low white cell count. *Note:* If you wish to review ratios with your class, go over the following example: In a city there are 3,000 buses and 1,000,000 cars. What is the ratio of cars to buses?

$$\frac{1{,}000{,}000 \text{ cars}}{3{,}000 \text{ buses}}$$

To reduce the ratio, divide the top and bottom of the fraction by 1,000; $\frac{1{,}000}{3}$, which is read as 1,000 cars to 3 buses.

5. The ratio of red blood cells to white blood cells in:

$$\text{males} = \frac{5{,}000{,}000}{7{,}000} = \frac{5{,}000 \text{ red blood cells}}{7 \text{ white blood cells}}$$

$$\text{females} = \frac{4{,}500{,}000}{7{,}000} = \frac{4{,}500}{7}$$

6. $7{,}000 \times 30 = 210{,}000$ white blood cells.

7. $\frac{35{,}000}{7{,}000} = \frac{5 \text{ platelets}}{1 \text{ white blood cell}}$

8. Males and females have the same number of platelets.

ANSWERS TO QUESTIONS

1. The smear was stained with red and blue dyes.
2. See figures on pages 9 and 10 of the text.
3. Round.
4. They are stained. Some parts of the cell take the blue dye and some take the red dye.

3 WHEN YOU BLEED Pages (13) 13 - (16) 16

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe how a blood clot forms.
b. examine clot formation microscopically.
c. measure clotting time.
d. describe some of the factors that affect clotting time.
e. compute the average clotting time of the class.

TEACHING TIPS

1. The introduction and Section A discuss the mechanism, and the value to the body, of blood clotting. Questions 1 and 2 point up the significance of the process. The Blood-Clotting Activity gives the students an exciting opportunity to see a blood clot actually forming.
2. Section B discusses health factors in clotting time. Results from the Clotting-Time Activity are used to give practice in computation.
3. For drawing blood, review *Keeping Alive,* Chapter 1, Drawing-Blood Activity. CAUTION: Follow all safety precautions given in *Keeping Alive,* Chapter 1, student text and *Teacher's Guide.*
4. For use of the microscope, see the microscope activities in "Action Biology," *The Invisible World,* Chapters 1 and 2.

BLOOD-CLOTTING ACTIVITY

Materials (per pair of students)

slide	disposable sterile lancet
marker	absorbent cotton balls
soap	microscope
70% alcohol	lens tissue
paper towels	

Preparation of Materials

For preparation of 70% alcohol, see *Teacher's Guide, Keeping Alive,* Chapter 1.

Notes on the Activity

1. In Step B the purpose of prefocusing the microscope is to enable the student to examine the drop of blood without loss of time. In order to see the first fibrin threads the student must work quickly, because they form within seconds.
2. In Step G, at the edge of the blood drop there will be a narrow zone of plasma, then a zone of red cells just 1 or 2 cells deep. The first minute threads of fibrin form amid the outermost red cells. It is easy for the student to miss seeing these first threads completely.
3. As Step H directs, students should leave the slide in focus and return to it from time to time during the period to observe the changes that take place. They will see the fibrin threads grow and thicken, while the clot darkens, shrinks, and develops cracks.

CLOTTING-TIME ACTIVITY

Materials (per student)

slide	70% alcohol
needle or pin	absorbent cotton

Notes on the Activity

1. In Step A, to reopen the puncture, students should firmly but gently squeeze the finger below and around the puncture. For best results, use a large drop of blood.
2. In Step C remind students to record in minutes and seconds the starting time and the time when a visible fibrin thread forms.
3. In Step D, after obtaining the drop of blood, the finger should be disinfected with alcohol-soaked cotton.
4. In Step G it is easier to compute average clotting time if each student reports his or her individual clotting time in seconds.

ANSWERS TO QUESTIONS

1. As the clot grows, more threads appear; the threads grow thicker and longer, and they meet, branch, and combine to form a network.
2. The blood.
3. It keeps germs out of the body.
4. The time may vary from 2 to 8 minutes.
5. If you wish to review the computation of an average with your class, go over the following example:
A biology class has 6 rabbits which weigh 6 kg, 4 kg, 3 kg, 5 kg, and 7 kg. What is the average weight of the rabbits?

$$6 + 4 + 3 + 5 + 7 = 25$$

$$\text{average weight of rabbits} = \frac{25 \text{ kg}}{5 \text{ rabbits}}$$

$$= 5 \text{ kg}$$

The average clotting time of the class will be in the neighborhood of 3 minutes.
6. Answers will vary.
7. A person may bleed to death from a small cut.
8. A clot inside the body is good if it stops internal bleeding after an injury. Blood clots which form inside of a blood vessel are dangerous, since they may block circulation. If they travel to the brain, heart, or lungs, they may be fatal.

4 WHAT'S A BUFFER? Pages (17) 17 - (20) 20

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe some characteristics of a buffer, an acid, and a base.
b. explain what the pH of a substance indicates.
c. use litmus paper to test for pH.
d. demonstrate the ability of a buffer to soak up acid.

TEACHING TIPS

1. As an introductory discussion, refer to students' familiarity with the omnipresent TV ads for buffered aspirin. (The possible advantage of buffered over plain aspirin is by no means unquestioned.)
2. In Section B use questions 1 and 2 to ensure that students understand the pH concept.
3. In Section B use the rhetorical question "Why don't acid drinks such as soda pop harm us?" as the basis for a class discussion. Encourage the students to make "educated guesses." Acidic materials are neutralized by the digestive system before they are absorbed into the blood.
4. Within the body, the principal buffers are proteins, carbonates, phosphates, and hemoglobin. The kidneys also help maintain pH by eliminating excess acid and base.
5. Note the unusual capitalization of pH. The term comes from the phrase "potential of hydrogen ion."
6. pH is also treated in "Action Biology," *Food*, Chapter 5, and *Ecology*, Chapter 12.
7. Before doing the activity, tell the students that in the laboratory we measure pH by means of indicators, substances which change color as the pH changes. Litmus is a common indicator. It turns pink in acid solution and blue in basic solution.

pH-AND-BUFFER-ACTION ACTIVITY

Materials (per pair of students)
- 2 small test tubes
- test tube rack
- 2 stirring rods
- full range pH paper (optional)
- red litmus paper
- blue litmus paper (optional)
- beaker of water, approximate pH 7.4
- beaker of simulated blood plasma (0.1 M phosphate buffer, approximate pH 7.4)
- dropper bottle 0.4 M HCl

(per group)
- assorted liquids: cola, milk, tap water, fruit juice, ammonia, bleach, milk of magnesia, antacid, liquid detergent

Preparation of Materials

1. To prepare 0.4 M HCl, take 33 ml concentrated HCl and add it to distilled water to make 1 liter of solution. CAUTION: Add acid slowly to water. Never add water to acid.
2. Adjust the pH of water so it is slightly basic (pH 7.4) with 0.4 M HCl or 0.4 M NaOH. The pH need not be precise so long as the water is basic to litmus. Check with litmus paper to ensure that 1 or 2 drops of 0.4 M HCl will change the water from basic to acid.
3. To prepare 0.4 M NaOH, dissolve 8 g NaOH in 500 ml of distilled water. The solution should be kept in a tightly stoppered

container. CAUTION: Handle solid NaOH with forceps.

4. The simulated blood plasma is actually 0.1 M phosphate buffer, approximate pH 7.4. Prepare as follows:
   a. Stock solution A: 0.2 M solution of monobasic sodium phosphate (NaH_2PO_4), 27.8 g in 1000 ml of distilled water.
   b. Stock solution B: 0.2 M solution of dibasic sodium phosphate, 53.65 g $Na_2HPO_4 \cdot 7H_2O$ or 71.7 g Na_2HPO_4 $12H_2O$ in 1000 ml of distilled water.
   c. Take 19.0 ml of stock A and 81 ml of stock B; add sufficient distilled water to make 200 ml of buffer.
   d. Adjust pH with stock solution A or stock solution B. Add yellow food coloring to simulate the straw color of plasma. Check with litmus paper to ensure that 4 or more drops of 0.01 M HCl changes the basic blood plasma to an acid.
   e. Above solutions can be stored indefinitely.
5. Stirring rods are easily made from short lengths of glass rod whose ends have been fire polished.

Notes on the Activity

1. Use baby food jars as substitutes for beakers and dropper bottles. A tin can or jar is a usable test tube rack.
2. When testing pH, students should use the stirring rod to place a small drop of the solution being tested on the litmus paper. Do not dip the paper in the solution.
3. In Step I the results will be as follows:

Buffer Action

	Water	*Blood Plasma*
Original pH (acid or basic)	basic	basic
Number of drops of acid required to change pH	or 2	7 or more

4. In EXTRA Step L, students may use either red and blue litmus paper, or full-range pH test paper. Results will be as follows:

   Acidic: cola, orange juice, milk
   Basic: bleach, ammonia, antacid, milk of magnesia, detergents

ANSWERS TO QUESTIONS

1. A base.
2. pH 7.
3. The blood plasma.
4. Blood can soak up a lot of acid or base without changing its pH.
5. A strong chemical with a low pH which neutralizes a base. Examples will vary.
6. A strong chemical with a high pH which neutralizes an acid. Examples will vary.

5 CRIME LAB Pages (21) 21 - (22) 22

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. demonstrate the presence of blood by the hemin test.
b. complete a self-test of his knowledge about blood.
c. write a short paragraph about some aspect of blood.

TEACHING TIPS

1. The TEST YOURSELF WORKSHEET constitutes a review of Chapters 1 through 4 of *Keeping Alive*. Use the WORKSHEET for a reading lesson in which the students are encouraged to use the text and their notes.

2. Use HOW WELL CAN YOU SAY IT? to give the students practice in reading, writing, and speaking skills. Let students use text and notes in preparing their paragraphs.

IDENTIFYING-BLOOD-STAINS ACTIVITY

Materials (per pair of students)
dry salted blood slides
glass cover slips
dropper bottles of glacial acetic acid
alcohol lamp
mystery blood slides
microscope
microscope lamp
lens tissue

Preparation of Materials
To prepare the mystery blood slides, use real blood for positives. For negatives, add a drop of water if necessary and 5 salt crystals (NaCl)

to a drop of red ink, ketchup, red food dye, or red paint. Stir and allow to dry.

Notes on the Activity

1. Use the salted blood slides which were prepared in *Keeping Alive*, Chapter 1.
2. CAUTION students about the dangers of concentrated acids. If they get acid on their skin or in their eyes, immediately flood the area with water, then seek medical attention.
3. In Step A use glass cover slips only. Plastic slips will melt when heated.
4. In Steps B and D you may want to add the acid to the slides yourself.
5. To clean dirty slides easily, soak them in hot soapy water.
6. Students enjoy the mystery slides in Step H. Some of the slides should contain blood, while others should be negative. Tell the students that the blood-like material on the mystery slides was collected at the scenes of various crimes. The assignment is to find out if the material is really blood.

TEST YOURSELF WORKSHEET

1. C	6. C	11. A or C	16. B
2. A	7. D	12. A	17. A
3. B	8. C	13. D	18. B
4. A	9. A	14. B	19. D
5. B	10. A	15. D	20. A

ANSWERS TO QUESTIONS

1. Hemin crystals are columnar, rhombic, and needle-like.

2. Reddish-brown.
3. Yes or no.

6 THE HEART PUMP Pages (23) 23 - (26) 26

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe the job performed by the heart.
b. manipulate models to demonstrate how the heart works.
c. measure the heart rate.
d. listen and record heart sounds.
e. describe the circulatory functions of veins, arteries, and capillaries.

TEACHING TIPS

1. Students should work in pairs of the same sex. Every student is expected to perform each activity.
2. Set up activities at various stations in the room and have teams go from station to station. If the materials are available, set up several extra stations of Heart Activities B, C, and E.
3. This is a wet lab. Have paper towels, rags, a mop, and a pail available for quick and easy cleanup.
4. To lessen breakage, use metal or plastic equipment wherever possible.
5. Caution students against horseplay in the laboratory.
6. Rubber bulbs, double-acting, pressure and suction, are available from Sargent Welch—Cat. No. S-73125, and Fischer Scientific Co.—Cat. No. 14-085.
7. Have students answer the WORKSHEET questions as they proceed through the activities.

HEART ACTIVITY A

Materials

rubber bulb, double-acting, for pressure and suction
rubber, plastic, or glass tubing
2 plastic or metal containers

Notes on the Activity

1. Add red food dye to the water.
2. The bulb illustrates 1-way flow through a pump equipped with a valve. Ask students:
   a. How is the bulb like the heart?
   b. What do they observe about the bulb's action?
   c. Why does the colored water flow only 1 way?

HEART ACTIVITY B

Materials

quart measure (cup or container)
2 oz. ($\frac{1}{4}$ cup) measure
2 large pails
clock with second hand

Notes on the Activity

1. Students will accept the challenge to compete with the heart in work output, and will be astonished by the result.

2. Use 6 or more liters of water so students will not have to tip the container. Containers must remain flat on the table while students are performing the activity. Students can use the quart measure to measure the amount of water moved.

3. Record on the board how much water each student can move in 1 minute. Organize a race among the top water movers in the class.

HEART ACTIVITY C

Materials

stethoscope
clock with second hand
70% alcohol
absorbent cotton

Notes on the Activity

1. Help students locate their hearts. Boys may wish to place the stethoscope diaphragm inside their shirts.

2. Clean the ear pieces of the stethoscope with alcohol and dry it after each use.

3. Help students who are having difficulty calculating the average class heart rate per minute.

HEART ACTIVITY D

Materials

clock with second hand

Notes on the Activity

The pumping of blood causes the foot to bounce in time with the heart beat. Some students will have difficulty seeing the slight bouncing action of the foot. If the shoe is removed, the foot is relaxed, and the student looks at the tip of the big toe, the beat is readily seen.

HEART ACTIVITY E

Materials

tape recorder and tape

Notes on the Activity

Unless you use a good tape recorder with a sensitive microphone, do not expect the students to be able to record their heartbeat before exercise. After exercise the heartbeat is fairly easy to record. Boys may wish to record their heatbeat by placing the microphone under their shirts.

HEART ACTIVITY F

Materials

rubber bulb, double-acting, for pressure and suction
plastic, rubber, or glass tubing
6 short pieces of glass tubing
2 glass or plastic cylinders
4 rubber stoppers to fit glass cylinders
red dye
thin plastic or rubber sheet, 1 inch square
pin or tack
2 ring stands
2 ring stand clamps to hold glass cylinders

Preparation of Materials

1. The short pieces of glass tubing will be needed to connect the plastic or rubber tubing to the rubber bulb and stoppers. Fire polish the ends of all glass tubing and cylinders. Use heavy work gloves or rags to protect your hands when working with glass tubing. Always wet tubing with glycerin or soapy water before inserting it into the rubber bulb or stoppers. Drill appropriate size holes in rubber stoppers. Corks may be used instead of rubber stoppers. Make sure that the rubber bulb is in the proper pressure suction direction. When the model is assembled, attach it by the cylinders to the ring stands. Fill the model with red-dyed water. Tape the stoppers to the cylinders and the model is ready. Some teachers find that the model works best if a second bulb is attached between the cylinders of the lower tubing.

2. A chemistry teacher can be most helpful in lending you materials and in helping you assemble the model.

Notes on the Activity

1. Although the model roughly illustrates the principle of a closed circulatory system, there are discrepancies. There are no capillaries and the heart is only 1-chambered.

2. Caution students to work the model gently.

3. If you cannot set up the model, then use the illustration to discuss how it works.

HEART WORKSHEET

1. The water moves from 1 container to another.
2. Blood.
3. The bulb pumps water as the heart pumps blood.
4. Answers will vary.
5. No.
6. Answers will vary. Approximately 72.
7. Answers will vary. Approximately 72.
8. Answers will vary. Approximately 72.
9. They are the same.
10. Pumping of blood by the heart.
11. Heartbeat is faster, louder, and stronger.
12. Yes. (In "Action Biology," *Keeping Alive,* Chapter 8, this will be discussed in more detail.)

13. Yes.
14. Vein.
15. Yes. One-way valves.
16. Answers will vary. (Children are challenged by this type of question and enjoy working out the answer.)
17. Three hundred liters in an hour, 7,200 liters in a day, 2,628,000 liters in a year.

7 TUBES FULL OF BLOOD Pages (27) 27 - (30) 30

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. demonstrate and identify capillaries in the tail of a fish.
b. explain the function of capillaries.
c. describe some characteristics of capillaries.

TEACHING TIPS

This chapter deals with capillary circulation. Introduce the subject by having students press their skin to demonstrate the observations of circulation that are discussed on page 27.

GOLDFISH ACTIVITY

Materials (per pair of students)
goldfish
wide mouth jar or large beaker
dropper
aged water or aquarium water
Petri dish
2 half microscope slides
absorbent cotton
microscope
microscope lamp
lens tissue
small test tube with 0.1% chloretone solution

(per class)
aquarium
fish net
recovery aquarium (optional)

Preparation of Materials

1. Have extra goldfish on hand to replace the few that may die. Care in handling and avoidance of over-anesthetizing will reduce the losses to few or none.
2. Use a glass cutter to cut microscope slides in half. Sand the cut edges of the slides with garnet paper.
3. Remove and store microscope stage clips.
4. Age water by letting it stand for 24 hours. Only aquarium water or aged water should be used with fish.
5. Prepare 0.1% chloretone anesthetic solution by adding 1 ml of chloretone to 1 liter water.

Notes on the Activity

1. Use small goldfish. Stock them in a large, well kept aquarium filled with aged water and equipped with aerator and filter. Use the aquarium also for recovery of anesthetized fish but be sure anesthetic does not get into tank.
2. In Step A have students catch their fish by trapping the fish with a net and dropping the fish into a beaker or jar filled with aquarium water. Dispense 5 ml or $\frac{1}{2}$ inch of chloretone anesthetic solution in a test tube, to be added to the beaker.
3. In Step B caution students not to overanesthetize their goldfish. It is also possible to use *unanesthetized* fish, although they may flop around and have to be repositioned several times.
4. Demonstrate Step C. Wrap a goldfish in wet cotton. Place it in a Petri dish with the tail spread between half slides. The gills should be well covered, and the mouth and tail exposed.
5. In Step D keep the cotton wet with aquarium water (no anesthetic present).
6. In Step E the thin area near the edge of the tail should be placed over the stage opening. The large red masses seen under low power are pigment cells. The blood vessels are arteries and veins containing masses of bloods cells, and narrow, thin-walled capillaries through which red blood cells travel in single file. You may want students to draw what they see.
7. If the blood cells stop moving, the goldfish is in trouble. The fish either has been overanesthetized, its respiration has been impaired through drying out, or pressure from the slides has cut off circulation in the tail. Revive the goldfish by pushing it through the water in the aquarium.
8. As an EXTRA procedure, students may test the effects of chemical vasodilators and vasoconstrictors on blood flow and the size of blood vessels. Remove the top half slide, apply 1 drop of any of the following chemicals to the tails, replace the slide, and wait a few minutes for the chemical to diffuse. Apply only 1 solution to any fish. Rinse off the chemical before returning the fish to the aquarium. Record results on the chalkboard.

Discuss results in relation to the effects of alcohol, nicotine, and other drugs on the body.

Vasodilators (slows down flow of blood):
- 2% alcohol—add 2 ml of ethyl alcohol to 98 ml of water
- coffee—weak solution

Vasoconstrictors (speeds up flow of blood):
- 0.01% adrenalin—either use adrenalin that has been diluted 10,000 to 1 or dilute it yourself by adding 1 drop of adrenalin to 700 ml of water.
- nicotine—soak a nonfilter cigarette for 1 hour in 100 ml of water, filter before using.

FINGERNAIL ACTIVITY

Materials (per pair of students)
- emery boards
- dropper bottle of oil of wintergreen
- microscope
- gooseneck lamp
- lens tissue

Preparation of Materials
Oil of wintergreen or methyl salicylate is a flavoring agent available in drugstores. It is an irritant that stimulates blood flow and clears the skin.

Notes on the Activity

1. In Step A caution students not to rub their skin with the emery board until it bleeds.
2. In Step C a bright light (e.g., high intensity lamp) must shine on the finger while the student carefully focuses with the low power. It is exciting for students to see their own capillaries. The capillaries look like small loops. Some students may even see red blood cells passing through them.

ANSWERS TO QUESTIONS

1. Near the edges of the tail.
2. Capillaries were narrow and had thin walls.
3. By their shape and color.
4. Capillaries are about 1 red blood cell wide. The cells flow through them in single file.
5. No. The blood flows, then stops and flows again.
6. No. It may go in either direction.
7. They carry blood to every part of the body. They take blood from arteries to veins.

8 HAVE A HEART Pages (31) 31 - (36) 36

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. name the parts of the heart.
b. tell the function of valves in the heart and veins.
c. describe some diseases of the heart.
d. describe some circulatory diseases, their prevention, and methods of treatment.
e. state and support opinions on legal and social aspects of health problems.

TEACHING TIPS

1. This chapter is useful for a reading and discussion lesson. Help the students read a short passage, then hold a brief discussion, illustrated with a demonstration or visual aid when possible.
2. In Section A, illustrate the heart structure with a simple dissection of a sheep or calf heart.
3. Sections B and C deal with circulatory valves. Demonstrate and review valve action in the model constructed for *Keeping Alive*, Chapter 6, Heart Activity F.
4. Students show strong interest in discussions of open heart surgery, treated in Sections D and E.
5. Sections F, G, and H deal with nutritional aspects of circulatory health. This topic is also taught in "Action Biology," *Food*, Chapters 7 and 8.
6. In the HEART DISCUSSION have each small group choose 1 question from the first 4 questions for resolution within the group. Then ask each group to make a short presentation to the class for open discussion.

ANSWERS TO QUESTIONS

Questions 1–4 call for opinions supported by reasons. Answers will vary greatly.

5. Heart disease was the number 4 killer in 1900. Today it is number 1.
6. See table, PRINCIPLE CAUSES OF DEATH IN THE U.S. IN 1900 AND 1973. Infectious diseases have dropped. Circulatory disease, cancer, and accidents have become more significant.
7. Due mainly to the automobile.

9 THE CIRCULATION GAME Pages (37) 37 - (38) 38

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. trace the flow of blood through the human circulatory system.

b. list the jobs performed by blood.

TEACHING TIPS

1. Use the Circulation Game as a direct, exciting, painless way for students to learn the path of blood through the body.

2. As a follow up on the activity, go over the diagram of the human circulatory system. Discuss the functions of the structures involved, and what happens to the blood as it travels through the organs of the body.

Materials (per group of 2, 3, or 4)

Chart of Circulation	scissors
deck of cards	markers
credit slips	

Preparation of Materials

1. Distribute copies of the Chart of Circulation (blackline master #1). In a pinch, students can play on the Chart in their books.

2. Decks of cards can be made by cutting 3×5 index cards in half. The first time you teach the chapter it will take a class about 15 minutes to prepare the decks of cards. Store the decks for re-use.

3. Draw 5-cm squares for credit slips on stencils or duplicating masters, reproduce them, and have students cut them out.

4. As markers, use initialed small slips of paper, small objects such as beans, rice, or markers from commercial games.

10 YOU'VE GOT RHYTHM Pages (39) 39 - (40) 40

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. find and measure the pulse in various parts of the body.

b. explain what the pulse is.

c. investigate the effects of rest, hyperventilation, standing at attention, and exercise on pulse rate.

d. compute the average pulse rate from a series of readings.

e. relate pulse rate to physical fitness.

TEACHING TIPS

1. Before students begin the experiments, they must learn to take pulse readings accurately, as explained and illustrated in Section A.

2. Students should work in pairs. One member of each pair serves as the experimenter, the other as the subject. After all experiments have been performed, students reverse their roles and repeat the experiments. Students in poor health should serve as experimenters only.

3. The PULSE WORKSHEET serves to summarize the various activities in the chapter. In each activity students may take the pulse for a full minute, or for 30 seconds and multiply by 2, or for 15 seconds and multiply by 4.

4. Normal pulse rate varies considerably from individual to individual. Some of the factors that can affect pulse rate are temperature, time of day, age, physical development, physical condition, and health. Generally, girls have a faster pulse rate than boys.

5. Carbon dioxide in the blood is a stimulant to the heart and to the pulse rate. Exercising, standing at attention, holding the breath, or breathing into a paper bag, causes an increase in the carbon dioxide level of the blood, and thus an increase in the pulse rate. Deep breathing decreases the level of carbon dioxide in the blood and thus decreases the pulse rate.

In *Keeping Alive,* Chapter 13, the effect of exercise on carbon dioxide production is studied.

6. In Section C students may rest on newspapers spread on the floor so as not to soil their clothes. The exercises called for may be deep knee bends, running in place, or

stepping on and off a chair. Show your students how to make a line graph from their data.

7. EXTRA. Have students calculate average pulse rates for boys, girls, and boys and girls combined. Have them determine the class range, from high to low, in each activity.

8. EXTRA. Compare pulse rates of smokers and non-smokers, using groups matched in weight and sex.

Materials

clock with second hand
newspapers
paper bags (optional)

PULSE WORKSHEET

Your Pulse Record

Answers will vary. Sample data for 1 student—

Normal pulse	74
Temple pulse	74
Neck pulse	74
Resting pulse	74
Standing pulse	78
After breathing pulse	66

After exercise pulse rates:

Immediately after exercise	112
After 2 minutes	94
After 4 minutes	78
After 6 minutes	74
After 8 minutes	74

Pulse Rates of Different People

Average Girls	80.5
Average Boys	76.7
Average Boy Athletes	68.9
Average Girl Athletes	74.1

ANSWERS TO QUESTIONS

1. To get the pulse rate per minute. Thirty seconds is half a minute.
2. They are the same.
3. The heart pushing the blood through the arteries.
4. They are the same. Since the heart pushes blood through all the arteries in the body at the same time, the pulses must be the same.
5. Answers will vary. Four to 6 minutes is average.
6. Yes. Females have a faster pulse rate than males.
7. Lower pulse rate.
8. The more physically fit you are, the lower your pulse rate, and the faster the pulse will return to normal after exercise. The heart of a physically fit person is stronger, and pumps more blood with less effort.

11 COOLING IT Pages (41) 41 - (44) 44

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe temperature changes in cold-blooded animals.
b. contrast temperature regulation in cold-blooded and in warm-blooded animals.
c. tell how the human body controls its temperature.
d. use and read an oral thermometer.
e. interpret a graph showing changes in body temperature.
f. describe some functions of the skin.
g. recognize that most snakes are harmless.

TEACHING TIPS

1. Snakes interest everybody and frighten many. Use this introductory material to generate a discussion of facts and fancies about snakes. Show a small non-poisonous snake if possible.
2. The animals in the photo montage at the bottom of page 41 are all cold-blooded—or, more correctly, homeothermal.
3. Besides the variations shown in Section C, many people have average body temperatures that vary slightly from 98.6° F.
4. Sections D, E, and F discuss temperature regulation and other functions of the skin. Freely refer to the drawings in discussing these functions.

TEMPERATURE ACTIVITY

Materials (per group of 2 or 3)
oral thermometer
jar of 70% alcohol
jar of water
cotton balls

Preparation of Materials
1. Buy inexpensive oral thermometers. If you need more, ask students to bring them from home, or borrow some from the school nurse.
2. Use beakers or baby food jars for the water and the alcohol.

Notes on the Activity
1. Some students will have difficulty reading the thermometer. Show them how to use and read it.
2. Place the chart in Step E on the board and have students make entries on it.
3. In Step G exercise or warm clothing will elevate the body temperature slightly.

ANSWERS TO QUESTIONS

1. Environment.
2. 37° C (98.6° F)
3. Human temperature stays fairly constant regardless of the ambient temperature.
4. Alcohol hand.
5. Alcohol.
6. They evaporated or dried up.
7. The alcohol evaporates faster.
8. Evaporation.
9. Highest around noon, lowest around midnight. Temperature varies with activity.
10. According to the graph, highest is 37.8° C, 99.7° F; lowest is 36.6° C, 98° F. These figures are not precisely accurate because the numbers on the scales are rounded off.
11. 37° C, 98.6° F.
12. They help regulate body temperature, and they get rid of some body wastes.
13. Beads of water form on hand and in bag.

12 BREATHING IN AND OUT Pages (45) 45 - (48) 48

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. tell why we need air.
b. describe the respiratory system and name its parts.
c. explain how the respiratory system works.
d. describe the functions of various specialized breathing apparatus.
e. describe the job of an inhalation therapist.
f. determine lung capacity.

TEACHING TIPS

1. Introduce the topic of respiration by asking the students to compare our need for air with various other requirements of life.
2. In Section B ask for student experiences with snorkels, oxygen masks, and other special breathing equipment. Discuss the job of an inhalation therapist.
3. Students should do the RESPIRATORY SYSTEM WORKSHEET utilizing direct observation and experimentation on animal plucks and on their own bodies.

RESPIRATORY SYSTEM WORKSHEET

Materials (per class)
1 or more plucks
bell jar model respiratory system
spirometer
meter stick
chart of human respiratory system
model of human respiratory system
antiseptic mouthwash or alcohol
absorbent cotton

Preparation of Materials
1. A pluck from a cow or sheep is obtainable from a butcher. It can be kept frozen until you are ready to use it. It consists of the 2 lungs with attached windpipe. Keep refrigerated or iced at all times.
2. Construct or purchase bell jar model shown in the upper figures on page 48 in the text. The diaphragm is a rubber sheet, bunched in the middle and tied with a string.
3. Purchase or build a spirometer. The lower figure on page 48 shows a spirometer constructed of a gallon bottle, a 2-hole stopper, and fire polished glass tubing.
4. To prepare 70% alcohol, mix 25 ml of water with 70 ml of 95% alcohol.

Notes on the Activity
1. Place the various items of equipment at stations around the room. Have small groups progress from station to station and complete the worksheet questions in their notes.
2. In using the spirometer, the student breathes out through the mouthpiece and displaces a measurable volume of water into the graduate. After each use, refill the gallon bottle with water, and wash the mouthpiece with alcohol or an antiseptic mouthwash.
3. Warn students not to abuse the balloon lung model.

4. Students may have difficulty doing the calculation on the bottom of page 48.
5. Students can measure heights against chalkboard.

ANSWERS TO QUESTIONS

1. Light.
2. Smooth.
3. Pinkish red.
4. It floats. It is filled with air.
5. A pipe with rings in it.
6. The windpipe is hard. Lungs are soft. Windpipe is reinforced with cartilage rings, which prevent it from collapsing.
7. In the upper part of the windpipe.
8. It divides into 2 short pipes (bronchi) which go to the lungs.
9. The correct labels are: 1—voicebox, 2—trachea or windpipe, 3—bronchia or branches, 4—lung, 5—rib cage or chest, 6—diaphragm.
10. Lungs.
11. Windpipe and bronchi.
12. Chest or rib cage.
13. Rubber sheet.
14. Balloons fill up.
15. When the diaphragm pulls down, the lungs fill with air. As diaphragm and chest wall expand, outside pressure forces air into lungs.
16. When the diaphragm pushes up, air is forced out of the lungs.
17. When you breathe in, the chest expands. When you breathe out, the chest returns to its resting size.
18. Answers will vary. In adult population 500 ml is average.
19. Answers will vary.
20. Answers will vary.
21. Answers will vary.

13 POWER IN THE CELLS Pages (49) 49 - (52) 52

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. define oxidation.
b. describe cell respiration.
c. compare burning and cell respiration.
d. relate carbon dioxide production to cell respiration.
e. measure respiration by measuring carbon dioxide production.

TEACHING TIPS

1. Referring to text and pictures on page 49, stress that oxidation includes both rapid burning, as in a fire, and cellular oxidation or cell respiration within the body. To reinforce this concept, work through the BURNING AND CELL RESPIRATION tables on page 50 with the students.
2. The Cell Respiration Activity determines the rate of cell respiration by measuring carbon dioxide output. The measurement depends on titration using phenolphthalein, an indicator which is red in basic solution and colorless in acid or neutral solution. When carbon dioxide is bubbled through water, it forms carbonic acid. If water containing phenolphthalein appears colorless, then carbon dioxide may be present in the form of its derivative, carbonic acid. Sodium hydroxide, a base, neutralizes the carbonic acid. The amount of added sodium hydroxide required for neutralization indicates the amount of carbon dioxide that was present. Before doing the activity, explain as much of this rationale as you think your students can handle.

CELL-RESPIRATION ACTIVITY

Materials (per pair of students)
dropper bottle of 1% phenolphthalein indicator
dropper bottle of 0.04% sodium hydroxide solution
2 bottles, beakers, or jars
100 ml graduate
stirring rod
water

Preparation of Materials
1. If your tap water is alkaline, use distilled water. Or you can neutralize your water with 0.01 M HCl.
2. To prepare a solution of phenolphthalein, dissolve 1 g phenolphthalein in 100 ml of 95% ethyl alcohol.
3. To prepare 0.04% sodium hydroxide solution, dissolve 0.4 g sodium hydroxide in 1000 ml of distilled water. Store in a tightly stoppered bottle.
4. If the water containing indicator requires too many drops of 0.04% sodium hydroxide to turn the phenolphthalein slightly pink, use 0.4% sodium hydroxide (4 g in 1000 ml of water) or 1% sodium hydroxide (10 g in 1000 ml of water).
5. Food jars (e.g., large baby food jars) may be substituted for the bottles.

6. Graduates can be improvised by pouring 100 ml of water into a jar or bottle and marking its level with a magic marker, file, or diamond stylus.

Notes on the Activity

1. In Step C the solution should turn *just barely* pink.
2. Remind students to record in the table, MEASURING CARBON DIOXODE, the number of drops of sodium hydroxide used in Steps C, G, K, and L.
3. In Step H results will vary. However, the number of drops of NaOH used should be least for the control and after sitting quietly, and most after vigorous exercise.
4. In Step L students may run in place, step on and off a chair, or do deep knee bends or pushups.

ANSWERS TO QUESTIONS

1. Food
   Oxygen
   Carbon dioxide and water vapor
   Energy
2. No flame
   Low or medium
   Slow
   Controlled
3. Most CO_2 was produced after vigorous exercise. Least CO_2 was produced after sitting quietly.
4. Yes.
5. It increases.
6. Oxygen—food.
7. It tells us how much carbon dioxide was in the water before we bubbled our breath through it.

14 THE BODY BALANCER Pages (53) 53 - (58) 58

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. explain why excretion is a necessary function of the body.
b. name the organs of excretion.
c. describe the functions of the kidney.
d. tell what an artificial kidney machine does.
e. describe diabetes.
f. explain the chapter title.
g. perform a urinalysis, and identify normal and abnormal results.

TEACHING TIPS

1. Use the pictures on page 53 in discussing the necessity for excretion. Compare excretion in the body with waste disposal in society.
2. The rectum is mentioned in the chapter without extended discussion because its main function is elimination of unused food rather than excretion of cellular metabolic wastes. Discuss this point if students bring it up. The digestive system is taught more fully in "Action Biology," *Food*, Chapter 11.
3. In discussing the kidney in Section B, illustrate the discussion with models and charts of the excretory system and with a fresh kidney cut open to show internal structure. Stress both the excretory and the homeostatic or regulatory functions of the kidney. Help students to explain the chapter title. In forming urine the kidneys not only excrete cellular wastes, but also regulate the salt and water balance, pH, and other conditions of the blood.
4. pH is treated in *Keeping Alive*, Chapter 4.
5. Distribute copies of URINALYSIS WORKSHEET (blackline master #2). After doing the practice activity on simulated urine, you may want to have students do a real urinalysis on their own urine. Students generally attack this task with both keen interest and equanimity. Be very wary, however, of letting students make their own interpretations of anomalous results. A result such as a heavy protein concentration is an indication that a student should visit a doctor, not make a self-diagnosis.
6. Urine is about 95% water and 2% urea. The remaining 3% consists of uric acid, creatinine, various salts, kidney tubule casts, discarded cells, and other normal minor constituents.

PRACTICE URINALYSIS ACTIVITY

Materials (per pair of students)

- 4 test tubes
- test tube rack
- test tube holder
- 10 ml graduate
- 2 droppers
- beaker
- hot plate
- Bunsen burner
- marker
- stirring rod
- safety goggles
- bottle of simulated urine
- dropper bottle of Benedict's solution
- dropper bottle of 5% acetic acid
- red and blue litmus paper
- paper towels
- paper cups

Preparation of Materials

1. To prepare "practice" urine, dissolve in 1000 ml of water:

10 g glucose
5 g albumin or the white of 1 egg
5 g sodium chloride
5 drops ammonia

Since the simulated urine should be positive for all tests, the above amounts are not critical. Color the urine with tea or yellow food coloring. If the simulated urine is not acidic, add a few drops of HCl. Store in a refrigerator.

2. For Step Q prepare several unknowns. Omit the sugar or albumin from some of the mystery samples, or make the pH basic. The sample of "mystery practice" urine may be the student's own specimen.
3. Fire polish the ends of glass stirring rods.
4. Use food jars or cans as test tube racks.

Notes on the Activity

1. In Step C girls' urine is cloudier than boys' because of the abundance of discarded cells.
2. In Step D fresh, sterile urine is almost odorless. The characteristic ammonia odor is rapidly produced by the breakdown of urea into ammonia. Bacteria hasten this breakdown. The characteristic odor is often modified by asparagine and other substances we eat.
3. In Step F, Clinistix or Labstix may be used instead of Benedict's.
4. In Step I set up several hot plates of boiling water around the room to heat test tubes.
5. In Step J there are many causes for a positive glucose reaction besides diabetes or similar pathology. Glucose normally appears in the urine shortly after a meal. Menstruation, mental or physical stress, and various other factors may also cause a positive glucose reaction. A diagnosis of diabetes depends on a fasting blood sugar or a glucose tolerance test; the urinalysis is used simply for screening.
6. In Step L make sure that students wear goggles as protection against splattering from the boiling liquid in the test tube.
7. At the conclusion of the activity, students should rinse all glassware and wash their hands.
8. EXTRA. Although tests for the various salt constituents of urine are not part of a standard urinalysis, your students can test for this normal component of urine. Add a few drops of silver nitrate to 5 ml of urine. The formation of a cloudy white precipitate indicates the presence of salt. To prepare 1 M silver nitrate, dissolve 17.0 g $AgNO_3$ in 1000 ml of distilled water. Store and dispense in brown bottles.

URINALYSIS WORKSHEET

Test	*Practice Urine*	*Mystery Practice Urine*
Color	Answers will vary	Answers will vary
Appearance	Answers will vary	Answers will vary
Odor	Like urine	Answers may vary, as after eating asparagus
pH	Acid	Answers will vary
Sugar	Present	Answers will vary
Albumin	Present	Answers will vary

ANSWERS TO QUESTIONS

1. The lungs, sweat glands, and kidneys excrete cellular waste products. The rectum eliminates undigested food.
2. Blood is passing from the injured kidneys into the urine.
3. Sugar or glucose.
4. By a blood or urine test for sugar.
5. A urinalysis is a lab procedure in which urine is tested for various substances.
6. In sickness the body's cells are affected, and they may produce abnormal wastes. These show up in the urine.
7. (b) blood, (d) tube (ureter), (e) bladder, (f) urethra.

15 JOBS IN THE HEALTH FIELD Pages (59) 59 - (64) 64

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe work and training requirements for various occupations in the health field.
b. relate school interest to a possible health career.
c. find and compare health career jobs in newspaper classified advertising sections.

TEACHING TIPS

1. This chapter may be used as a combined career education and reading lesson.
2. Have students select their areas of school interest, and briefly discuss with their groups

or with the class health-career possibilities in these areas.

3. Go over unfamiliar words in the word guide and in the HEALTH CAREERS TABLE. Have a dictionary available and encourage your students to use it.

4. Ask your school nurse, a doctor, a dentist, or some other resource person in the health field to speak to the class about health careers and to answer questions.

5. Ask the administrator of your local hospital to arrange a behind-the-scenes tour.

6. Students can obtain additional information about health careers from: the library; the guidance counselor; the U.S. Department of Labor, *Occupational Outlook Handbook;* the American Medical Association, Council on Medical Education, Chicago; the American Dental Association, Council on Dental Education, Chicago; Registry of Medical Technologists, American Society of Clinical Pathologists, Chicago; and your state Health Careers Council.

HEALTH CAREERS ACTIVITY

Materials

newspaper classified advertising sections

Notes on the Activity

1. Ask students to bring in their own newspapers. You will have to provide additional papers for students who neglect to bring any in.

2. Tell students to turn to the HEALTH CAREERS TABLE for help in locating appropriate listings in the newspaper.

3. Be prepared to help your students with the abbreviations used in the classified ads.

ANSWERS TO QUESTIONS

1–5. Answers will vary.

SUPPLIES AND EQUIPMENT

Large Equipment

Aquaria
Clock
Hot plate, electric
Lamps, gooseneck or high intensity
Lamps, microscope
Microscopes, compound
Tape recorder and tape

Small Equipment

Aquarium equipment (optional)
Beakers, large
Beakers, medium
Bell jar model respiratory system
Bunsen burners
Corks, assorted
Cover slips, glass
Dissecting needles
Droppers
Dropper bottles
Fish net
Forceps
Graduates, 10 ml
Graduates, 100 ml
Lamps, alcohol
Lancets, disposable, sterile
Lens tissue
Litmus paper, blue (optional)
Litmus paper, red
Meter sticks
Petri dish
pH paper full range (optional)
Ring stands
Ring stand clamps
Rubber bulbs, double-acting, pressure and suction
Rubber stoppers
Safety goggles
Scissors
Slides, standard microscope
Spirometer (purchase or construct)
Stethoscope
Stirring rods
Test tube holders
Test tube racks
Test tubes, small
Thermometers, oral
Tubing, glass
Tubing, rubber or plastic

Chemicals

Acid, glacial acetic
Acid, hydrochloric
Alcohol, isopropyl or ethyl
Alcohol, methyl
Ammonia
Benedict's solution
Blood staining kits
Chloretone anesthetic
Glucose
Oil of wintergreen
Phenophthalein indicator
Silver nitrate (optional)
Sodium chloride
Sodium hydroxide
Sodium phosphate, dibasic
Sodium phosphate, monobasic

Biological Materials

Goldfish

Consumables Obtainable Locally

Baby food jars
Bleach
Cans, empty
Cola
Cotton, absorbent
Cotton balls, absorbent
Detergent, liquid
Eggs
Emery boards
Food coloring, red
Food coloring, yellow
Fruit juices, assorted
Index cards (3x5)
Jars, large
Markers, glass
Measure, ¼ cup (2 oz.)
Milk
Milk of magnesia
Newspapers
Newspaper classified advertising sections
Pails, large
Paper towels
Pins
Pluck (lungs), sheep or cow
Quart measure (cup or container)
Soap
Toothpicks

AUDIOVISUAL MATERIALS

For meaning of abbreviations, see *Teacher's Guide*, page 131.

Arteriosclerosis. B&W, 14 min., American Heart Assn. (Presentation of the problem for laymen and students.)

The Blood. Color or B&W, 16 min., EBE. (Composition, functions, and circulation of the blood; blood typing.)

Breathing Movements—Respiratory System—Breathing. Film Loop, EBE.

Circulation. Color or B&W, 17 min., United World Films. (Animated diagrams emphasizing structure and function of heart, lungs, arteries, veins, and capillaries.)

Circulation: Closed Transport Systems. Film Loop, BFA.

Circulatory Control. Filmstrip, Popular Science.

Control of Body Temperature. B&W, 11 min., EBE. (Explains mechanism simply; contrasts warm-blooded and cold-blooded animals.)

Coronary Heart Disease. Color, 6 min., American Heart Assn. (Similar to film on arteriosclerosis.)

Daphnia. Film Loop, BFA.

Heart Disease—Its Major Causes. B&W, 11 min., EBE. (High blood pressure, hardening of arteries, symptoms of rheumatic fever, and causes of heart attack.)

Heart—How It Works. B&W, 11 min., MGH. (Structure, function and circulation of the heart.)

Heart in Action. Film Loop, EBE.

Hemo the Magnificent. Color, 60 min., in two parts. American Telephone and Telegraph Co. (Adapted from elaborate television program using dramatization and animation.)

Homeostatic Regulation. Filmstrip, Popular Science.

Horizons Unlimited. Color, 28 min., Modern Talking Picture Service. (Depicts careers in medicine and allied fields.)

The Human Body: Circulatory System. Color, 14 min., Coronet or American Heart Assn. (Besides circulation, film deals with the lungs and the kidneys.)

The Human Body: Excretory System. Color or B&W, 14 min., Coronet. (Structure and function in relation to homeostasis; presented on a simple level.)

The Human Body: Respiratory System. Color or B&W, 14 min., Coronet. (Structure and function presented simply.)

Human Physiology. Filmstrip Series, Society for Visual Education.

The Hurdler. Color, 16 min., New York Times and Arno Press. (Biography of Dr. Charles Drew, who established the first blood banks.)

I Am a Doctor. Color, 30 min., American Medical Assn. and Sterling Movies, U.S.A. (Discusses medicine as a career.)

In a Medical Laboratory. Color, 28 min., Your State Society of Medical Technologists. (Shows pathologists, medical technologists and other laboratory personnel working together.)

The Kidney, Film Loop, EBE.

Mechanics of Breathing. Filmstrip, Popular Science.

Mechanisms of Breathing. B&W, 11 min., EBE. (Structure and function of respiratory system.)

Open Heart Operation. B&W, 27 min., MGH. (Made at the University of Minnesota, a leading center in this field.)

Our Heart and Circulation. Filmstrip, Popular Science.

Regulating Body Temperature. Color, 22 min., EBE.

Respiration. B&W, 12 min., Univ. (Descriptive and simple.)

Respiration. B&W, 28 min., MGH-AIBS Series. (Cellular respiration and adaptation in multicellular animals.)

Respiration in Man. Color, 26 min., EBE.

Secret of the White Cell. Color, 28 min., Prism Productions. (Phagocytosis of white blood cells.)

Story of the Bloodstream—Part I: The Heart and Circulation. Color, 29 min., Moody. (First half of an extensive presentation. The heart machine is included in Part I.)

Story of the Bloodstream—Part II: The Red Blood Cell. Color, 24 min., Moody.

The Systematic Approach to Physiology. Filmstrip Series, Eye Gate.

Tobacco and Your Health. Sound Filmstrip, Society for Visual Education.

Understanding Your Body I and II. Filmstrip Series, EBE.

White Blood Cells. Color or B&W, 12 min., MGH. (Shows white cells battling infection. Includes electron cinematographs.)

Work of Blood. B&W, 11 min., EBE. (Composition and function of blood, transfusions, and blood typing.)

The Work of the Blood. Filmstrip, Popular Science.

The Work of the Kidneys. B&W, 11 min., EBE. (Brief and simple.)

Your Kidneys—Living Filters. Filmstrip, Popular Science.

FOOD

CONTENTS

PLAN AHEAD for the following lessons:

Chapter 5 Collect cans for constructing calorimeters.
8 Collect wire coat hangers for food mobiles.
11 Obtain Daphnia or Tubifex.
13 Obtain tripe from a butcher shop.
14 Collect newspaper classified advertising sections.
15 Collect food labels.

1 WHY EAT? Pages (3) 67 - (8) 72

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. state the biological reasons why we need food.

b. state the psychological reasons why we eat.

c. list the nutrients which regulate the body,

supply energy, and supply chemical spare parts.

d. describe and perform the tests for starch, sugar, protein, salt, fat, and water.

e. detect the presence of starch, sugar, protein, salt, fat, and water in a food.

TEACHING TIPS

1. Be sure to stress the distinction between the biological reasons why we need food and the psychological and social reasons why we eat.

2. You may want your students to use water as a control for the various nutrient tests. CAUTION: Many of the chemicals used in this activity can burn (Biuret reagent), poison (iodine and silver nitrate), or stain (iodine and Benedict's solution). Students should avoid getting them in contact with eyes, skin, or clothes.

NUTRIENT ACTIVITY

Materials

brown dropper bottle of iodine (or Lugol's solution)
dropper bottle of Biuret solution
dropper bottle of Benedict's solution
brown dropper bottle of silver nitrate
hot plate
400 ml beaker
test tubes
test tube rack (or tin can)
test tube holder
brown paper bag
Bunsen burner
marker
salt (sodium chloride)
bread
raisins
mashed egg white
oil or margarine
assortment of foods: cheese, hot dog, beans, peas, meat, carrot, potato, banana, apple, dry cereal, oatmeal, molasses, etc. All food should be either macerated or cut into small pieces.

Preparation of Materials

1. To prepare a 1% silver nitrate solution, dissolve 1 g silver nitrate in 100 ml of distilled water. Store in dark bottles only.

2. Commercially prepared Benedict's solution is available from most scientific supply houses.

3. To prepare iodine solution, dissolve 3 g potassium iodide in 25 ml of distilled water. Add 0.6 g crystalline iodine, stir until dissolved, and bring up to 200 ml by adding water. Store in dark bottles. Alternatively, use Lugol's iodine solution.

4. Biuret solution can be purchased from most scientific supply houses or it can be prepared as follows:

Prepare a 0.01 M solution of copper sulfate by dissolving 2.5 g copper sulfate in 1 liter of water. Prepare 10 M sodium hydroxide by dissolving 440 g sodium hydroxide in a small amount of water; then add water to bring solution to 1 liter. Prepare fresh Biuret solution just before use by adding 25 ml of the copper sulfate solution to 1 liter of the sodium hydroxide solution. Discard when solution becomes discolored.

5. The concentration of sodium chloride is not critical. A teaspoonful of salt dissolved in a glass of water will work nicely.

Notes on the Activity

1. This is an activity which always works, and which students enjoy. Because of the large number of procedures involved, however, a successful outcome depends to a great extent on careful organization of the laboratory class.

2. If students work in pairs, most of the materials can be shared by several pairs. Caution students to avoid the use of dirty droppers and test tubes, as these may ruin their test results. Have students clean and rinse their test tubes after each use to avoid the excessive use of glassware.

3. Set up 1 or 2 hot water baths in the room. Use electric hot plates, if possible, instead of Bunsen burners. Caution students that when heating a sample the open end of the test tube should be turned away from all people.

4. The test for water, Step J, may best be done as a class demonstration. In this test, a piece of bread gives unequivocal results. First ask students if they think bread contains any water. Students are always amazed at the amount of water that comes from the "dry" bread.

5. In Step C, the test for sugar, use small amounts of Benedict's solution for a quick reaction. Show the students the technique of mixing the contents of the tube by swirling.

6. For Step H, the test for fat, cut your brown paper bag into 10-cm $\times$ 10-cm squares. Clarify the difference between a water spot and a fat spot by letting the water evaporate before reading the test.

7. Some teachers prefer to use cooked and/or macerated foods for this activity.

8. In Step A, the test for starch, you may wish to substitute a 1% starch suspension for the bread. To prepare a 1% starch suspension, stir 1 g starch into a paste-like consistency in a small amount of water. Slowly stir the starch paste into some boiling water. Cool, and add additional water to bring the slurry to 100 ml.

9. In Step C, the test for sugar, you may wish to substitute a 1% glucose or dextrose solution for the raisins. To prepare a 1% glucose or dextrose solution, dissolve 1 g of the sugar in 100 ml of water.

10. In Step F you may wish to use liquid egg white for the test for protein. Mix the white of 1 egg in just enough water so that it may be dispensed with a dropper.

NUTRIENT WORKSHEET

Nutrient	*Job in the body*	*Test: What did you do?*	*Test: What did you see?*	*Foods that contain the nutrient*
Starch (a carbohydrate)	supply energy	food and iodine	blue or blue-black color	bread, beans, cereal
Sugar (a carbohydrate)	supply energy	food and Benedict's solution, and heat	green, yellow, orange, or red color	raisins, carrot, banana, apple, molasses
Protein	supply chemical spare parts	food and Biuret solution	purplish (red) color	egg white, milk, cheese, gelatin, meat, hot dog, beans
Salt (a mineral)	regulate the body	food and silver nitrate	white cloudy color	salt water, hot dog, cheese
Fat	supply energy	food rubbed on brown paper	translucent grease spot	oil, margarine, cheese, hot dog
Water	regulate the body	heat food in bottom of test tube	water droplets in upper part of test tube	bread, meat, carrot

ANSWERS TO QUESTIONS

1. To supply energy and chemical spare parts, and to regulate the body.
2. Minerals.
3. Blue or blue-black color. (Color reaction is dependent on concentration of iodine solution. A very weak iodine solution gives a blue color, while a more concentrated iodine solution gives a blue-black color.)
4. Different colors indicate the presence of different amounts of sugar.
5. No. The oil spot is translucent. Also, the oil spot remains, but the water spot dries up.
6. Vitamins.
7. $140.
8. $2500.
9. Answers will vary.

2 VITAMINS Pages (9) 73 - (12) 76

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe what the major vitamins do for the body and name the foods that contain them.

b. discuss the advantages and disadvantages of taking vitamin pills.

c. perform the indophenol test for vitamin C.

d. measure the amount of vitamin C in a variety of juices, and plot a graph of the results.

e. prove that heat destroys vitamin C.

f. tell how the special nutritive value of citrus juices was discovered.

TEACHING TIPS

1. Discuss with the class the advantages and disadvantages of taking vitamin pills. Who needs vitamin pills? Does vitamin C fight the common cold? Do we need vitamins if we eat a balanced diet? Can too much of a vitamin hurt you? (Excess of vitamins A or D is harmful.)
2. Discuss how the body benefits from vitamins other than those described in the text. What foods contain them?

Students can perform many additional experiments:

3. Exposing a juice to air reduces its vitamin C content; have students test some juices that have been left standing for a day at room temperature in open containers.

4. Some people add sodium bicarbonate when cooking vegetables to preserve the color; students can investigate whether sodium bicarbonate reduces the vitamin C content of juice.

VITAMIN ACTIVITY

Materials

0.1% indophenol solution
1.0% vitamin C (ascorbic acid) solution
test tubes
test tube rack (or tin can)
droppers
Bunsen burner or hot plate
beakers, baby food jars, or other containers for solutions and juices
fruit juices: orange, grapefruit, lemon, grape, apple, pineapple, others

Preparation of Materials

1. In preparing for this activity, adjust the concentrations of indophenol and ascorbic acid solutions so that about 5 or 6 drops of ascorbic acid solution will decolorize the indophenol.
2. To prepare a 0.1% indophenol solution, dissolve 1 g indophenol in 1000 ml of distilled water. Purchase indophenol from supply houses under the chemical name 2,6-dichlorophenol indophenol.
3. Ascorbic acid is sold in drugstores in solutions of various strengths. Purchase a 10% ascorbic acid solution and dilute as required. To prepare a 1% solution of ascorbic acid, mix 10 ml of 10% ascorbic acid with 90 ml of water.
4. To slow the decomposition of vitamin C, store vitamin C test solution and juices in sealed containers in a refrigerator.

Notes on the Activity

1. Indophenol is a blue indicator which is decolorized in the presence of vitamin C. Students should ignore the intermediate pink color that may appear.
2. Remind the students that the more juice needed to bleach the indophenol, the lower the vitamin C content of the juice being tested.
3. Students should rinse and dry tubes after each use.
4. Demonstrate to the students how they can mix the contents of their test tubes by swirling.
5. For Step D, instead of having each student boil juice individually, you may prefer to boil 1 beaker of juice or vitamin C solution for 5 minutes for the whole class.
6. Help the students adjust the bar graph of their results on page (12) 76. In Step E they may have to use more drops of juice than are indicated on the graph.

ANSWERS TO QUESTIONS

1. It keeps blood vessels healthy and prevents scurvy—sore gums, loose teeth, and bleeding from blood vessels.
2. Vitamin D helps the teeth. Vitamin A helps the eyes. Vitamins A and B complex help the skin.
3. Answers will vary.
4. Answers will vary.
5. Heat destroys vitamin C.
6. Juices tested.
7. Number of drops.

3 WHAT'S SO GREAT ABOUT MILK? Pages (13) 77 - (16) 80

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe why milk is considered an almost perfect food.
b. determine some of the major components of milk.
c. describe some of the foods made from milk.
d. tell why protein deficiency diseases such as kwashiorkor are a world problem.

TEACHING TIPS

1. Not everybody can drink milk. Some children are allergic to it. Some people lack the enzyme diastase, which digests milk protein.
2. In some groups of people, if milk is not given to a child for a period of time, the child loses the ability to produce the enzyme lactase, which digests milk sugar, or lactose. When later in life these children are given milk, the lack of the enzyme prevents them from digesting the milk and creates gastric discomfort. This condition is found in some black Africans and other groups who do not include dairy products in their diet after infancy. This is why some children who suffer from kwashiorkor cannot be given milk as a protein source. On the other hand, high protein soybean foods ameliorate the disease.
3. As enrichment, visit a local dairy.

MILK ACTIVITY

Materials

skim milk or powdered milk
heavy cream

lactic acid
white vinegar
small dish or Petri dish half
spoon
hot plate
Bunsen burner
tripod
filter paper or paper towelling
funnel
test tube
test tube rack (or tin can)
crucible
gloves or tongs
beakers or sauce pans

Preparation of Materials
It is difficult to find unhomogenized milk. Therefore, make your own by adding heavy cream to skim milk or to reconstituted powdered milk. Display the "nonhomogenized" milk in beakers or bottles, and either pour off the cream or remove it with a pipette.

Notes on the Activity
1. This activity may be performed by groups of 4 students or by the teacher as a demonstration.
2. In Step A a few drops of lactic acid are added to the partially filled test tube of cream to hasten butter formation. If lactic acid is unavailable, substitute acetic acid (vinegar), although the latter will slightly modify the flavor of the butter. Butter formation requires several minutes of vigorous shaking.
3. In Steps D and E paper towelling may be used as filter paper.
4. In Step E, as the whey comes to a boil, milk albumin will appear in the form of light curds. This albumin is removed by filtration.
5. You may wish to perform Step F as a demonstration. Pour some whey into a watch glass and place on top of a beaker of boiling water. Or, boil the whey on the low heat of a hot plate. After the water evaporates from the milk, a small amount of milk sugar (lactose) will remain.
6. In Step G place some whole milk into a crucible and heat slowly over a Bunsen burner until all the liquid has evaporated. Then heat strongly until a gray-white ash remains. This step may be done as a demonstration.
7. Students can perform on whole milk the nutrient tests for fats, proteins, salt, starch, sugar, and vitamin C. All tests will be positive except those for vitamin C and starch.

ANSWERS TO QUESTIONS

1. Vitamins A and D.
2. Fat, protein, sugar, water, and minerals.
3. Ice cream, ice milk, cottage cheese, yogurt, sour cream, buttermilk, cream cheese, American cheese, and other cheeses.
4. Feed the children protein found in milk or soybean foods.
5. Make sure that the diet includes sufficient protein. Relatively inexpensive sources of protein include such foods as beans, eggs, cheese, powdered milk, soybeans, peanut butter, and oatmeal.

4 THE COW IN THE KITCHEN Pages (17) 81 - (20) 84

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. explain the scientific basis for cooking starchy foods.

b. describe how cooking alters the make-up of certain foods.

c. list 5 reasons for cooking food.

d. define the word "digest."

e. use the iodine test to identify starch grains and verify the effect of cooking on starch grains.

f. prepare dextrin from starch and identify it.

CAUTION: Iodine is a poison. Warn students not to eat food with iodine on it.

STARCH ACTIVITY

Materials
slide
cover slip
microscope
dropper bottle of iodine solution (or Lugol's solution)
beaker of dilute iodine solution
scalpel or single-edged razor blade
raw potato
boiled potato
cooking starch
hot plate
pan
spoon
funnel
test tube
test tube rack (or tin can)
beaker
paper towels
scrap paper

sliced white bread
Bunsen burner
dissecting needles or tooth picks
non-instant pudding (optional)

Preparation of Materials
To prepare the iodine solution see *Teacher's Guide, Food*, Chapter 1.

Notes on the Activity
1. To review or teach the students how to use the microscope, see "Action Biology," *The Invisible World*, Chapters 1 and 2.
2. Students should work in pairs.
3. All students can perform Steps A to D (starch grains) and Steps K to M (location of dextrin in toast). Steps E to J may be performed as a teacher demonstration.
4. You may wish to have your students observe and draw starch grains before and after adding iodine to the potato scrapings.
5. Iodine solutions are often so concentrated that they give a very dark blue-black color reaction with starch. Instead, dilute your iodine solution in water (e.g., about $\frac{1}{4}$ teaspoon of 1% iodine solution in 1 cup of water) until it gives you a light blue color reaction. Use this weak iodine solution in Steps J and L.
6. For Steps K to M, instead of having the students toast bread in class, you may want to use medium brown toast from a home toaster. Store the toast in a plastic bag, so that it does not dry out, until you are ready to use it. For testing, use pieces about 2 × 4 cm.
7. For Step F paper towelling can be used in place of filter paper.
8. In Step G evaporate the water with low heat on a hot plate.
9. In changing starch into dextrin, gentle heat breaks down large starch molecules into smaller dextrin molecules. Dextrin dissolves in water, is slightly sweet to the taste, gives a reddish color with iodine solution, and is sticky when moist.

ANSWERS TO QUESTIONS

1. Cooking softens food, improves the flavor of food, makes food easier to digest, improves mouth feel of food, and kills germs in food.
2. They are oval, surrounded by a wall, and stained a dark blue-black color.
3. Made them dark blue-black in color.
4. The test for starch is a blue color reaction to iodine.
5. Starch spreads from the grains.
6. Sticky like glue.
7. Sweetish taste. Yes.
8. Dextrin gives a reddish color with iodine solution.
9. In the brown outer layers of the toast and in the crust.
10. The blue color in the inner portion of the toast indicates the presence of starch.
11. When the starch grains are heated, they burst open and combine with the water to form a jelly-like substance.
12. It is sticky and has a pleasant taste.

5 SCIENCE IN THE KITCHEN Pages (21) 85 - (24) 88

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. explain the scientific basis for certain cooking techniques.

b. explain and demonstrate the effect of salt, sugar, heat, and fresh water on food cells.

c. classify foods as acids or bases by using a pH indicator such as red cabbage juice.

TEACHING TIPS

In the text the authors have avoided the use of technical terms in discussing the concepts of diffusion, semi-permeable, selective diffusion, and osmosis. If your class can handle these terms, you may wish to define and use them.

VEGETABLE ACTIVITY

Materials
carrots
beets or potatoes
potato peeler
ruler
single-edged razor blade or scalpel
cork borer (optional)
beakers or baby food jars
table salt
spoons
red cabbage
Bunsen burner or hot plate
test tube rack (or tin can)
test tubes
baking soda
vinegar
assorted foods in jars, with droppers

Notes on the Activity
1. Students should work in pairs.
2. For Step B you can substitute white potato

for the beet. Also, try using a cork borer to make equal sized blocks of plant tissue. Students can measure the length of the blocks in centimeters or inches.

3. For Step C use very salty water, e.g., dissolve 16 g (2 teaspoonfuls) of table salt (NaCl) in 125 ml ($\frac{1}{2}$ cup) of water.

4. **Effects of Soaking Vegetables in Fresh Water and in Salt Water**

	Appearance after soaking in		*Length after soaking in*	
	Fresh water	*Salt water*	*Fresh water*	*Salt water*
Beet	rigid, firm	bendable, limp	2.7 cm	2.1 cm
Carrot	crisp, firm	bendable, limp		

Note that the original beet blocks were 2.5 cm $\times$ 0.6 cm $\times$ 0.6 cm.

5. In Step G, as the cell membrane is destroyed by boiling, it loses its semi-permeability and allows the purple cabbage juice to pass through it. You may wish to prepare the purple cabbage juice in advance. Concentrated solutions can be diluted with water for class use. Store the red juice in the refrigerator until needed. It can be kept frozen for relatively long periods of time.

6. If red cabbage is not available, the juices of cherries, rhubarb, and blueberries are all good pH indicators. You can also use, in place of the purple cabbage juice, a standard pH indicator such as litmus paper or 1% phenolphthalein. To prepare 1% phenolphthalein, see the *Teacher's Guide, Keeping Alive*, Chapter 13.

7. Have the students test the pH of some of the following substances: vegetable and fruit juices, cream of tartar, soda pop, egg white, tomato, cottage cheese, sour cream, antacid preparation, milk, milk of magnesia, etc. All substances should be in liquid form or should be macerated in distilled water.

8. The color range of purple cabbage juice indicator is pH 3 red, pH 4 to 5 pink, pH 6 to 7 purple, pH 8 to 9 green, and pH 10 yellow.

9. Students' answers on the ACID AND BASIC FOODS table will vary. Most foods that we eat are acid. Egg white, antacids, and milk of magnesia are basic.

ANSWERS TO QUESTIONS

1. The salt pulls the liquid out of the vegetable cells.
2. Fresh water keeps the vegetables crisp.
3. The salt made the beet blocks limp and easy to bend.
4. It made the carrot strips limp and easy to bend.
5. Green.
6. Red.

6 COUNTING CALORIES Pages (25) 89 - (28) 92

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. define a large and a small calorie.
b. explain why Calories are important to our body.
c. tell how food Calories are measured.
d. measure the number of Calories in a small piece of food by using a tin can calorimeter.
e. read and interpret a food CALORIE TABLE.

TEACHING TIPS

1. This chapter should take at least 2 days: 1 day to discuss the chapter and go over the worksheet, and 1 day to do the activity and calculations.

2. Go over the CALORIE WORKSHEET example with the class. Expect that even though the math is simple, the students will probably need help in doing the calculations.

3. The CALORIE TABLE consists of quantities of food which make up 100 Calorie portions. Ask students questions about the table. Which foods are high in Calories? Low in Calories?

4. As enrichment, have the students record the foods they eat during 2 days. Emphasize that for accurate determination, snacks must be included. Then have them use Calorie charts to calculate the number of Calories consumed per day.

5. **Materials for Section D** (per group)
beaker
hot plate or burner setup
laboratory thermometer (Celsius)
oral thermometer (Celsius)
alcohol (for washing oral thermometer)
cotton, absorbent
ice

CALORIMETER ACTIVITY

Materials

tin can calorimeter
10 ml graduated cylinder
pyrex test tube
thermometer (Celsius)
cork
needle or pin
peanut or walnut
cigarette ash
tongs or gloves
matches
gram balance

Notes on the Activity

1. Students should work in groups of 2, 3, or 4. If the calorimeters are already made, the activity will take 1 period. An additional period will be required if the students construct calorimeters.

2. To construct a tin can calorimeter, students will need a can opener (an electric opener is very convenient), juice can opener, pliers, tin shears, hammer, nails, and a vegetable can or soft drink can, or a large, paper frozen juice concentrate can. Construct the calorimeter according to the figures in the text. Bend down all sharp edges. The hole in the top of the can should be just large enough for the test tube to fit in tightly. A good way to make this opening is to cut or punch an "x" in the top of the can and then push a round object the same diameter as the test tube through the opening. Epoxy glue can be used to adjust the size of the hole for the tube. If need be, wind a rubber band around the test tube to make sure it doesn't fall through the opening. The cut out "v" on the side of the can should be large enough for the cork and nut to pass through. Several holes should be punched in the top of the can with a hammer and nail. Once made, tin can calorimeters can be used for several years.

3. For Step D remove the head of a straight pin and carefully push the cut end into a cork.

4. When the test tube is placed in the calorimeter, the bottom of the tube should be about 1 cm above the nut.

5. You may want the students to place a sheet of aluminum foil under the calorimeter to protect the table top.

6. In Step E the student must light the nut with a match and *quickly* push it under the can.

7. If the water in the tube boils, the student must repeat the experiment with a smaller piece of nut. If the nut stops burning, the student should immediately relight it and continue with the experiment.

8. The temperature gain from burning a peanut will be between 26° and 60° C.

9. Caution the students to be careful not to burn themselves with the hot calorimeter or test tube.

10. Caution the students to handle the thermometer carefully; remind them that the thermometer must be removed from the tube while the nut is burning.

11. Possible sources of error in using the tin can calorimeter are: (a) loss of heat through holes in can, (b) heat absorbed by can and thermometer, (c) errors in taking temperature of water, (d) error in the amount of water used.

12. You may wish to have the students weigh in grams the food they burn and then calculate Calories per gram. For example, on the CALORIE WORKSHEET, if the food sample weighed 0.25 grams, multiplying 1.2 Calories by 4 (1 g/0.25 g = 4) gives 4.8 Calories per gram.

ANSWERS TO QUESTIONS

1. They cannot burn.

D. Temperatures:
boiling water, 100° C at sea level;
ice water, 0° C;
air in the room, approximately 20° C;
outside air, variable;
mouth, close to 37° C.

7 YOUR RIGHT WEIGHT Pages (29) 93 - (32) 96

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. explain how both activity and the Caloric content of food affect body weight.

b. check his or her height and weight, and compare results with average weight for height.

c. explain why some people need more Calories than others.

TEACHING TIPS

1. With the class, discuss dieting both to gain weight and to lose weight.

2. The pinch test is performed at the waist. Be careful not to offend very fat and very thin students.

3. **Materials for Section C (per pair or group of students)**
meter stick
metric ruler
laboratory balance

CHECK YOURSELF ACTIVITY

Materials
bathroom scale
yardstick

Notes on the Activity
1. Students should work in pairs.
2. Height should be measured against the chalkboard.

ANSWERS TO QUESTIONS

1. Because the football player is more active than the bookkeeper, he burns more Calories.
2. Yes. You will get fat.
3. She may not eat a well balanced diet.
4. Exercise burns extra Calories. By eating less you take in fewer Calories, and thus do not have to do additional exercises to burn the food.
6. Hardcover edition, 28.5 cm; paperback, 27.7 cm.
7. Hardcover, 28 mm; paperback, 3.5 mm.
8. Hardcover, 1332 g; paperback, 169 g.
9. Hardcover, 1.3 kg; paperback, 0.169 kg.
10. Grams for paperback, kilograms for hardcover. More convenient, avoids large numbers (hardcover), avoids decimals (paperback).

8 THE BIG FOUR Pages (33) 97 - (36) 100

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. name the Basic Four Food Groups and give examples of foods in each group.

b. explain what is meant by the expression "empty Calories."

c. state the basic rules for a well balanced diet.

TEACHING TIPS: A FOOD MOBILE

Groups of students can make a food mobile out of a metal coat hanger, file folders or cardboard, and thin string. Additional materials needed include a ruler, scissors, single-edged razor blade, and coloring pencils or crayons. In constructing the mobile, ensure by trial and error that the meal cards are large enough to balance the small food cards.

TEACHING TIPS: BASIC FOUR RUMMY

1. Your students will find Basic Four Rummy an exciting way to learn about balanced meals and the Basic Four Food Groups.
2. The first time you teach this chapter, it will take the class about 30 minutes to make the deck of cards. Once the cards have been made, store them for future use.
3. Decks of cards can be made by cutting 3×5 index cards in half, cutting up ditto paper into 12 equal sized cards, each about 5 cm $\times$ 8 cm, or by using old cheap decks of playing cards. (Ball point pens write nicely on non-plastic cards.)
4. As foods for their deck of cards, students should choose from the Basic Four list on page 100 (36).
5. As enrichment, take the class for a behind-the-scenes tour of the school cafeteria. Ask the dietitian to discuss how she or he prepares balanced meals.

9 BELIEVE IT OR NOT ABOUT FOOD Pages (37) 101 - (38) 102

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. identify nutritional information as fact or nonsense.

b. give reasons for the decisions about nutritional fact and nonsense.

TEACHING TIPS

After the students answer the worksheet on their own, go over it and discuss the answers.

Solicit additional food facts, fads, and fancies from the class. Discuss fad diets and how advertising influences what we eat.

FACTS, FADS, AND FANCIES WORKSHEET

1. Disagree. It won't hurt you if you want to eat them together.
2. Disagree. It will not affect your digestion.
3. Agree. They provide vitamin C.
4. Disagree. Although they are acid foods, your stomach is acid all the time.
5. Disagree. A balanced vegetarian diet is very healthy.
6. Agree. Milk is rich in calcium and vitamin D, both of which are needed to build strong bones and teeth.
7. Disagree. All chemicals that are added to foods must be approved by the Food and Drug Administration or the Department of Agriculture. Chemicals that are found harmful are supposed to be removed from food products.
8. Disagree. All growing plants require chemicals from the soil. If fertilizers and insecticides were not used, we would probably not be able to grow a sufficient amount of food.
9. Disagree. Tomatoes are not poisonous.
10. Agree. Many paints contain poisonous lead.
11. Disagree. There is no such thing as "tired blood." If you are tired all the time, you should see a doctor.
12. Disagree. If you eat a normal, varied diet you do not need vitamin pills. Take vitamins only on a doctor's advice.
13. Disagree. There are no male or female foods.
14. Disagree. The meat in a cheap cut is just as nutritious as the meat in an expensive cut.
15. Disagree. All oils are high in Calories.
16. Disagree. Most people can digest cheese easily.
17. Agree. Some people cannot eat certain foods because of allergies or because the food disagrees with them.
18. Disagree. A pregnant woman does not need special foods, but she does need to eat a varied, well balanced, nutritious diet.
19. Agree. Many Americans are overweight. Obesity is believed to be a major cause of heart disease.
20. Disagree. Most diseases are due to germs, not to bad diet.
21. Disagree. Although processing of foods such as rice and wheat does remove vitamins and minerals, these foods are usually enriched with vitamins and minerals to make up for the nutrients removed during processing.
22. Disagree. Only medication administered by a doctor can cure syphilis.
23. Agree. Because teen-agers are generally more active than adults, they need more Calories.
24. Agree. If you cook foods in a lot of water, you cook the vitamins and minerals into the water. By using a small amount of water these nutrients remain in the food. Nutrient-rich water in which food has been cooked should be used in soups and gravies.
25. Disagree. You cannot make up a missed breakfast. Breakfast is an important meal because it comes after a night's fast.
26. Disagree. Both kinds of eggs contain the same nutrients.
27. Disagree. Certain vegetables can be eaten raw. All meats should be cooked because they may contain disease-causing germs which would be destroyed by the cooking process.
28. Disagree. They will not cure a cold; they may possibly keep away people who are infected with germs.
29. Disagree. Studies have shown that aluminum pots are perfectly safe.
30. Agree. To lose weight, a person must burn more Calories than he consumes.
31. Agree. All these are excellent inexpensive sources of protein.
32. Agree. The only nutrient that reconstituted dry milk does not contain is fat.
33. Disagree. They contain the same number of Calories. However, diet margarines contain less fat and have fewer Calories than regular butter.
34. Disagree. Toast contains more dextrin and less water than bread, but it has the same number of Calories.
35. Agree. Many Americans do not eat a properly balanced diet. Americans consume too much "junk food."
36. Disagree. Scientists do not agree that large quantities of vitamin C will definitely cure a cold.

10 CHEWING IT UP Pages (39) 103 - (42) 106

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. demonstrate by an experiment the action of saliva on starch.

b. define digestion.
c. describe the chemical and mechanical digestive processes that occur in the mouth.
d. trace the path that food travels down to the gullet.
e. describe the process of swallowing.
f. describe the function of the various teeth in eating.

TEACHING TIPS

1. Peristalsis will be discussed in more detail in the next chapter.
2. The teeth will be discussed in more detail in "Action Biology," *The Invisible World,* Chapter 13.

SALIVA ACTIVITY

Materials
clean rubber band
test tubes (6 per team)
marker
soda cracker
beaker
test tube rack (or tin can)
dark dropper bottle of iodine solution (or Lugol's solution)
dropper bottle of Benedict's solution
test tube holder
hot plate

Preparation of Materials
1. To prepare the iodine solution, see *Teacher's Guide, Food,* Chapter 1.
2. Commercially prepared Benedict's solution is available from scientific supply houses.

Notes on the Activity
1. Students should work in groups of 2, 3, or 4.
2. The day before the activity, ask the class to avoid eating candy, snacks, or chewing gum for 1 hour before the class meets.
3. Rinsing the mouth with water will remove most residual sugar.
4. Each team should collect 2 to 5 ml of saliva. Students may be repelled when saliva is being collected. Ask them to "spit" in such a manner that other students are not offended. Often, smelling oil of wintergreen or vinegar, chewing paraffin, or just moving the tongue around inside the mouth will stimulate the flow of saliva.
5. Be sure to use soda crackers that do not contain sugar. Since many brands of soda crackers contain sugar, some teachers use matzos or uncooked instant rice in place of crackers. When chewed, the uncooked instant rice has a pleasant, nutty taste.
6. For Step G students need add only 1 or 2 drops of iodine solution to get a color reaction.
7. Remind the students that in Step I they should use small amounts of Benedict's solution and mix by swirling before heating in a hot water bath.
8. Set up around the room several beakers of boiling water for the Benedict's test.

ANSWERS TO QUESTIONS

1. The chewed and unchewed cracker (or rice) contained starch.
2. The chewed cracker (or rice).
3. The saliva and cracker (or rice).
4. The sugar came from the cracker (or rice).
5. Food goes down the windpipe when the flap does not completely cover the opening.

11 THE HUNGRY FOOD TUBE Pages (43) 107 - (46) 110

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .
a. name, describe the structure, and state the function of each organ of the digestive system.
b. describe the work of Dr. William Beaumont.
c. describe the digestive tract and the digestive process in Daphnia.
d. name and describe the process of peristalsis.
e. describe the process of digestion.
f. list in the proper order the parts of the digestive system.

TEACHING TIPS

1. You may wish to discuss in more detail peristalsis and the functions of the liver, gall bladder, pancreas, and rectum.
2. The name of the hunter is Alexis St. Martin.

WATER FLEA ACTIVITY

Materials
depression slide
cover slip
Vaseline or soft wax
toothpick
dropper

Daphnia culture
yeast culture stained with Congo red
cotton or thread
microscope

Preparation of Materials

1. Daphnia may be obtained from a pond, fish pet store, or biological supply house.
2. To prepare a yeast culture stained with Congo red indicator, add a small pinch of Congo red powder to a thick suspension of dry yeast that has been mixed with water. Gently boil for 5 minutes. Store the cooled suspension in the refrigerator in a dropper bottle until you are ready to use it. A yeast culture stained with neutral red can also be used. It will show a more graded series of color pH changes in the digestive tract.
3. Right before the activity add some Congo red yeast suspension to the Daphnia (or Tubifex) culture that will be used by the class. It will take several minutes for the students to observe the color change from red to blue. Congo red is blue at pH 3 and orange-red at pH 5.

Notes on the Activity

1. Students should work in pairs.
2. Use cotton fibers or pieces of threads to trap the Daphnia.
3. If you do not have depression slides, regular microscope slides can be used. But have the students make a heavier ring of Vaseline or soft wax, and add a bristle to the cover slip to prevent crushing the specimen.
4. An effective way of making a thin Vaseline ring on the slide is to dip the open end of a test tube or small vial in the Vaseline, and then touch it to the slide. Vials can be obtained from a drugstore.
5. Demonstrate how to pick up Daphnia with a dropper for Step B.
6. Demonstrate how to perform Step D. Warn the students not to press down too hard on the slide.
7. If Daphnia are not available, substitute Tubifex worms. Tubifex can be purchased from tropical fish or pet shops. If the cotton or the threads do not trap Tubifex, you can stop the worms from moving around by anesthetizing them with formaldehyde or a saturated solution of magnesium sulfate (Epsom salt). Either add a drop of the magnesium sulfate solution to the cover slip before making the wet mount, or place the worm in some *very* dilute formaldehyde until it stops moving, and then mount it.

ANSWERS TO QUESTIONS

1. Yes.
2. The legs beat all the time and bring food to the mouth. It eats all the time.
3. The food is squeezed by peristalsis through the food tube.
4. Yes. (Not all students will be able to observe this.) In the food tube. The red-dyed yeast changed from red to blue. (Explain to the class that this shows the change in pH that occurs during the digestive process.)
5. It gets rid of waste food through the anus at the end of the food tube.
6. Both are long tubes.
7. Digestion is the breaking down of food so it can be passed into the blood.
8. Mouth, gullet, stomach, small intestine, large intestine, and anus.
9. Salivary glands, liver, pancreas, and appendix.

12 JUST PASSING THROUGH Pages (47) 111 - (50) 114

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe the absorption process.

b. describe the various structures involved in absorption in the small intestine.

c. demonstrate how glucose can diffuse through a membrane but starch cannot.

d. explain how starch is made useful to the body.

e. describe why most food has to be digested before it can be used by the body.

f. describe the general function of membranes in the body.

TEACHING TIPS

1. Display a rubber change mat and relate its appearance to the inside of the small intestine.
2. Show a chart of the small intestine and ask students to describe its appearance.
3. Show a model of a villus. Elicit that food must pass through the membranes to enter the blood.
4. Chitterlings is a food made from the small intestine of the pig.

INTESTINE ACTIVITY

Materials

cellophane dialysis tubing ($\frac{5}{8}$ inch)
thin string (e.g., kite string)

scissors
dropper bottle of sugar solution
dropper bottle of starch
100 ml beaker or small baby food jar
test tubes
test tube rack (or tin can)
brown dropper bottle of iodine (or Lugol's solution)
dropper bottle of Benedict's solution
test tube holder
hot plate

Preparation of Materials

1. To prepare the iodine solution, see *Teacher's Guide, Food,* Chapter 1.
2. Commercially prepared Benedict's solution is available from scientific supply houses.
3. To prepare a starch suspension, mix 1 g starch with 20 ml of cold water to form a paste. Then stir into 100 ml of boiling water. Continue to stir and boil until smooth.
4. A 60% glucose or dextrose solution, dilute molasses, corn syrup, or dilute honey can be used as the sugar solution. To prepare the glucose solution, dissolve 60 g glucose in 100 ml of water.

Notes on the Activity

1. Students should work in pairs.
2. Soak dialysis tubing in water to soften it. Then cut the tubing into 15-cm lengths.
3. Show students how to tie the tubing securely so no leaks will occur.
4. In Step B it is easier if eye droppers are used to fill the tubing with the solutions.
5. In Step E students should rinse the bag made of tubing under running water to remove any sugar or starch that may have spilled on the outside.
6. Absorption can be demonstrated within 5 minutes if the water is warm, the beaker is the smallest possible, and the volume of "blood" (water) is small.
7. For a more realistic activity, add red food coloring to the imitation blood in Steps D and E. The light red color will not interfere with the sugar or starch tests.
8. If necessary, review the tests for sugar and starch.
9. Set up around the room several beakers of boiling water for the Benedict's test for sugar.
10. You may want to perform the Intestine Activity as a class demonstration.
11. The following can be performed either as an extra by the teacher, or by the students: Set up the activity as indicated in the text, but fill the tubing only with starch suspension to which saliva has been added. Use an iodine test to show that starch does not pass through the membrane into the "blood"; use Benedict's solution to show that sugar now appears in the "blood" and in the dialysis bag. This demonstration vividly shows that the large starch molecule has to be digested into small sugar molecules before absorption can occur across a membrane.
12. **Nutrients in the "Blood"**

	Control Test Tubes of "Blood"	*After Removing "Intestine" from Beaker*
Is sugar present?	No	Yes
Is sugar present?	No	No

ANSWERS TO QUESTIONS

1. Sugar.
2. Starch.
3. Because it cannot get through the intestine membrane.
4. Starch is broken down into simple sugar, and the sugar passes through the membrane.
5. Digestion breaks food down; it can then pass through membranes and be used by the body.
6. It is long. It is wavy. The inside is not smooth, but is lined with millions of villi.

13 ENZYMES Pages (51) 115 - (54) 118

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe the digestive processes which occur in the stomach.
b. demonstrate by an experiment enzymatic breakdown of a protein such as egg white.
c. explain how an enzyme works.
d. tell some characteristics of enzymes.

TEACHING TIPS

1. Obtain from a butcher shop a section of tripe for student observation. Distribute small pieces of tripe and a hand lens to groups of students so that they may see the texture and structure of the stomach wall.
2. You may wish to discuss with your class some of the common disorders of the digestive tract, for example, ulcers, upset stomach, gall stones, constipation, appendicitis, and food poisoning.

PEPSIN ACTIVITY

Materials

egg
hot plate
beaker
single-edged razor blade
ruler
paper towels
test tubes (4 per group)
marker
dropper bottle of 0.5% pepsin solution
dropper bottle of 0.2% hydrochloric acid
dropper bottle of 0.5% sodium bicarbonate solution
test tube rack (or tin can)
rubber band
incubator
refrigerator

Preparation of Materials

1. All enzyme-containing solutions should be freshly prepared. They should be in the refrigerator when not in use.
2. Commercial pepsin may be obtained from a biological supply house.
3. To prepare dilute 0.2% hydrochloric acid, slowly add 2 ml concentrated hydrochloric acid to 998 ml of distilled water. Mix well.
4. To prepare 0.5% pepsin, dissolve 5 g pepsin in 1000 ml of distilled water.
5. To prepare 0.5% sodium bicarbonate, dissolve 1 g sodium bicarbonate in 200 ml of distilled water.

Notes on the Activity

1. Students should work in pairs.
2. Some teachers prefer to boil the eggs in advance or to have students bring hard boiled eggs from home.
3. Warn students to place the egg white on sheets of paper for cutting into squares.
4. In Step E students should mix 1-cm ($\frac{1}{2}$-inch) pepsin (P) with 1-cm ($\frac{1}{2}$-inch) hydrochloric acid (A) for tube P + A, and mix 1-cm ($\frac{1}{2}$-inch) pepsin with 1-cm ($\frac{1}{2}$-inch) sodium bicarbonate for tube P + B. In Step E, if you run short of the solutions, 1-cm ($\frac{1}{2}$-inch) in each tube is sufficient.
5. In Step F place 2 or 3 cubes of egg white into each test tube.
6. Place most of the sets of labelled test tubes in a 37° to 40° C incubator for 24 hours, or keep at room temperature (25° C) for 3 days. As controls, place several sets of labelled test tubes in the refrigerator for the same length of time. Occasionally shake all tubes.
7. After removing the tubes from the refrigerator, you may want to place them in a warm place for the same length of time as the original tubes were kept in a warm place. Thus, the students can see that although the cold temperature slowed down enzymatic activity, it did not permanently inhibit such action. In the pepsin + acid tube, the egg white will be digested.
8. Have the class interpret the results of the experiment as summarized in the table in Step K.

Tube Label	*In Warm Place*	*In Cool Place*
P	clear; no digestion (There may be slight digestion)	clear; no digestion
A	clear; no digestion	clear; no digestion
P + A	egg digested; cloudy	clear; no digestion
P + B	clear; no digestion	clear; no digestion

9. While waiting for the results of the activity, go on to another chapter. If you do not use an incubator, try to schedule the activity for a Friday so that you can see the results of the experiments on Monday.
10. If you wish, you can perform this activity as a demonstration.

ANSWERS TO QUESTIONS

1. In the P + A tube.
2. Pepsin works in acid but not in base.
3. Cold apparently stops digestion, but really slows it down greatly. Warmth speeds up digestion.
4. Hardly any breakdown of the egg occurred when the tubes were kept in the refrigerator. When tubes were kept in a warm place, digestion occurred. Pepsin works in acid but not in base. Pepsin does not digest proteins when acid is absent.
5. Stomach acid stops the enzymes in saliva from working.

14 JOBS WITH FOOD Pages (55) 119 - (58) 122

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. list vocational opportunities in the food industry.

b. explain the meaning of abbreviations frequently found in classified advertisements.

c. locate food industry jobs in newspaper classified advertising columns and give the training level requirements and salary of each job.

d. in the classified advertising section, locate businesses up for sale, describe the businesses, and give the requirements for buying them.

TEACHING TIPS

1. Although the FOOD JOB WORKSHEET can be completed from the classified want ad section on pages (57) 121 and (58) 122, it is more realistic for students to use the classified advertising section of the local newspaper. After going over the ads in the textbook, the students should be able to make use of the newspaper to complete the worksheet.

2. The worksheet can be done either individually or in groups of 2 or 3 students.

3. Discuss summer and part-time employment opportunities in the food industry.

4. Some of the less common abbreviations in the Classified Want Ad Section, page (57) 121, are: out of town (oot), thousands (M or K), days (d), and room and board (r & b).

Materials

classified advertising sections of the local newspaper (optional)

FOOD JOB WORKSHEET

1. The following abbreviations appear in classified ads. Find out from the ads or from a dictionary what each abbreviation means.

appt. appointment
attr. attractive
eve. evening
excel. excellent
ex. experience
gd. sal. good salary
hr. hour
lt. light
M thousand
M/F male or female
mo. month
nec. necessary
per hr. per hour
rel. reliable
sal. salary
wk. week or work
yr. year
+ plus

2. Pick 1 or 2 jobs that interest you at each training level. Complete the following table in your notebook.

Training Level	*Job*	*Salary*
High school not required	Cook's helper	$4,680
High school	Food sales	$7–10,000
Job training after high school	Manager trainee fast food chain	$8–10,000
Junior college	Assistant director food service	$8,000 +
Four year college	Food technologist quality control	$12,000
College + 4 additional years	Food technologist Ph.D.	$15–20,000

3. In your notebook, list jobs at each of these yearly salary levels.

$20,000 or more	chef, director quality control
$10,000	cook, butcher, baker
$ 8,000	fry cook, grillman, assistant restaurant manager
$ 6,000	busboy, waiter, waitress
$ 4,000	baker, apprentice, wrappers
$ 2,000	deliver pizza, car hop—all part-time

4. From the ads, pick a business that you would like to buy. In your notebook, record:

a. The name of the business
b. A brief description of the business
c. What you need in order to buy it
d. How much money you could expect to make from it
e. How you would run the business

Luncheonette
Serve breakfast and lunch, 6 a.m.–4 p.m.
$18,500
Gross $1,400, make $300 per wk.
Prepare some food myself and take care of cash register. Hire people to prepare food.

15 READ THE LABEL Pages (59) 123 - (64) 128

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. explain how an advertisement can differ from a food label.
b. identify and describe the various parts of a food label.
c. tell why additives are added to foods.
d. interpret the nutritional information on a label.
e. pick the most economical size of a particular food product.

TEACHING TIPS

1. Provide a variety of labels from cans, cereals, convenience foods, bread, cake, potato chips, and other packaged food products for the students to study.
2. Students can work individually or in pairs in examining the food labels.
3. Ask the class for examples of misleading advertising in which the product does not live up to advertising promises.
4. Additives: Monosodium glutamate is an amino acid derivative used to enhance the flavor of food. Disodium guanylate is a chemical used to give food a meat flavor. BHA and BHT are antioxidants which retard spoilage and flavor changes. Propionic acid, calcium and sodium propionate, sorbic acid, potassium sorbate, benzoic acid, and sodium benzoate are chemicals which are added to foods to slow down spoilage by retarding the growth of molds and bacteria. You may want to discuss the question "Could we get along without food additives?"
5. Use the cartoon on page (61) 125 to discuss the nutritional value and label disclosure of pet foods as compared to "people" foods.
6. Ask students how they can use the information on a food label to get more nutrition for their food dollar. Have students give examples.
7. Additional food-package information not discussed in the chapter: Cans have coded lot numbers and packing dates embossed on the covers.

ANSWERS TO QUESTIONS

1. Spaghetti with meatballs.
2. Franco-American Spaghetti with Meatballs.
3. Campbell Soup Company, Camden, N.J. 08101.
4. 418 g ($14\frac{3}{4}$ oz.)
5. Tomatoes. Water. Yes.
6. Flavoring. Citric Acid.
7. a. King Cole Mixed Vegetables.
   b. Quaker Oats.
   c. Domino Sugar.
   d. Kellogg's Frosted Pop-Tarts.
8. Cheerios—Nutrients: vitamin A, vitamin C, thiamin (B_1), riboflavin (B_2), niacin (a B vitamin), calcium, iron, vitamin B_6, vitamin B_{12}, and vitamin D.
9. Cheerios—Approximate composition: protein 13.3%, fat 6.9%, and carbohydrate 71.3%.
10. Water. Mushrooms. Wheatflour.
11. There is no U.S. shield.
12. 15-oz can, 2.33¢ per can; 25-oz can, 2.4¢ per can. The 15-oz can is cheaper.
13. Neither; costs are the same. The 2-liter carton may be more convenient.
14. 2-kg box costs $1.24 per kg and is cheaper.

SUPPLIES AND EQUIPMENT

Large Equipment

Hot plate, electrical
Incubator (optional)
Lamps, microscope
Microscopes, compound
Refrigerator

Small Equipment

Balance, gram (optional)
Beakers, assorted sizes
Bunsen burners
Corks
Cork borer (optional)
Cover slips
Crucible
Dialysis tubing ($\frac{5}{8}$ inch)
Dissecting needles
Droppers
Dropper bottles
Filter paper
Funnels
Graduates, 10 ml
Hand lenses
Petri dishes
Potato peeler
Razor blades, single-edged
Rulers
Scale, bathroom
Scissors
Slides, depression
Slides, microscope
Spoons
Test tube holders
Test tube racks
Test tubes
Thermometers
Tripod
Tongs
Yardstick

Chemicals

Acid, hydrochloric
Acid, lactic
Benedict's solution
Biuret reagent
Congo red indicator
Glucose
Indophenol
Iodine, crystalline (optional)
Lugol's iodine solution
Pepsin
Potassium iodide (optional)
Silver nitrate
Sodium bicarbonate
Sodium chloride
Starch
Vitamin C solution

Biological Materials

Daphnia
Yeast, dry

Consumables Obtainable Locally

Baby food jars
Baking soda
Beets
Bread, white
Cabbage, red
Cans, empty
Cardboard (optional)
Carrots
Classified advertising sections (optional)
Coat hangers, wire (optional)
Cotton, nonabsorbent
Cream, heavy
Eggs
Food, assorted
Food containers, labels, and wrappers
Fruit juices, assorted
Index cards, 3 × 5
Markers, glass
Milk
Needles
Nuts, peanuts or walnuts
Pan
Paper bag
Paper towels
Pins
Potato
Raisins
Rubber bands
Starch, cooking
Soda crackers
String, thin
Toothpicks
Tripe (optional)
Vaseline
Vinegar, white

AUDIOVISUAL MATERIALS

For meaning of abbreviations, see *Teacher's Guide,* page 131.

Digestion (Chemical). Color or B&W, 19 min., Univ. (Elementary, descriptive study of one aspect of the digestive process.)

Digestion (Mechanical). Color or B&W, 17 min., Univ. (Complements film on chemical digestion.)

Digestion in the Small Intestine. Film Loop, EBE.

Digestion of Foods. B&W, 11 min., EBE. (Brief descriptive account.)

The Digestive System. Color, 17 min., EBE. (Process of human digestion including X-ray motion picture photography.)

The Digestive Tract. Film Loop, EBE.

Enzymes—The Spark Plug of Life. Film Strip, Popular Science.

Evidence of Food Breakdown—Protein. Film Loop, EBE.

Food-Getting Among Animals. Color or B&W, 12 min., Moody. (Survey of various methods.)

Food, the Color of Life. Color, 26 min., Association Films.

Foods and Nutrition. B&W, 11 min., EBE. (Dietary requirements, absorption of sugars, and determination of basal metabolism.)

The Fuel of Life. Color or B&W, 29 min., Indiana.

G for Goldberger. B&W, 21 min., Teaching

Film Custodians. (The story of Dr. Goldberger's work with the U.S. Public Health Service in attacking pellagra.)

The Human Body: Chemistry of Digestion. Color, 16 min., Coronet.

The Human Body: Digestive System. Color or B&W, 14 min., Coronet. (Structure and functions; elementary.)

The Human Body: Nutrition and Metabolism. Color or B&W, 14 min., Coronet. (Presents the uses of food in metabolism.)

Human Digestion. B&W, 10 min., Contemporary Films. (Brief and elementary.)

Man's Digestive System. Filmstrip, Popular Science.

The Nature of Burning. Color or B&W, 16 min., MGH.

Obesity. B&W, 12 min., EBE. (Discusses causes, effects, and control.)

The Stomach in Action. Film Loop, EBE.

Swallowing. Film Loop, EBE.

Toward the Victory of Health. Color, 15 min., American Dietetic Assn. (Conquest of nutritional deficiencies through dietary research.)

Villi in the Small Intestine. Film Loop, EBE.

THE INVISIBLE WORLD

CONTENTS

NOTE: Chapters 1 and 2 are necessary preparation for microscope work in activities of Chapters 3, 4, 5, 6, 7, 8, 9, 10, 11, 13 (EXTRA) and 15.

PLAN AHEAD for the following lessons:

Chapter 2 Check parfocality of microscopes. Obtain microfossils, brine shrimp, rotifers.
3 Prepare envelopes containing "evidence of crimes."
4 Obtain a frog. Obtain tissue slides showing animal cells.
5 Obtain elodea, onions.
6 Order or culture paramecium culture.
7 Obtain cultures of various protozoa.
8 Purchase yeast. Prepare starter 1 day before activity.
9 Start bread mold cultures 4 to 7 days before activity. Instruct students to start cultures also. Collect mold specimens.
10 Prepare bean soup 2 days before activity.
11 Start sauerkraut 3 days before activity and yogurt 1 day before the activity.
12 Prepare milk samples.
13 Instruct students to bring in toothbrushes and toothpaste. Ask some students not to brush their teeth the morning of the activity.

14 Prepare nutrient agar and inoculate Petri dishes 3 days ahead of activity.
15 Collect or purchase protococcus, living cultures of spirogyra, prepared slides of conjugating spirogyra, and prepared slides of diatoms.

1 THE MICROSCOPE Pages (3) 131 - (6) 134

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. identify the parts of a compound microscope.
b. describe the function of each part of the microscope.
c. clean a microscope slide and cover slip.
d. prepare a temporary wet-mount microscope slide.
e. properly illuminate a microscope using diaphragm, lamp, and mirror.
f. focus a compound microscope with coarse and fine adjustments.
g. manipulate a slide on a microscope stage, under control.
h. compare macroscopic and microscopic appearance of the printed letter "e" and a newspaper photograph.

TEACHING TIPS

1. Because Chapters 1 and 2 deal with basic techniques, they should be taught before any other microscope lessons, whether from *The Invisible World* or from other units of "Action Biology."
2. You may want to introduce this chapter by demonstrating a magnifying or reading glass as an example of a simple microscope.
3. When going over the parts of the microscope, question 1, page (3) 134, ask students to correlate the name of the part with the number on the microscope illustration.

MICROSCOPE ACTIVITY

Materials (per student or per pair of students)
- compound microscope
- microscope lamp
- slide
- cover slip
- lens paper
- dissecting needle

(per group of 4)
- newspaper
- scissors
- beaker of water
- dropper

Notes on the Activity

1. The purpose of the activity is to introduce the student to the microscope and to give practice in its use. Spend only enough time on this preparatory lesson so that students can begin to use microscopes on their own to examine things.
2. Microscope work has high intrinsic interest. But before allowing individual work to begin, give a brief introduction to impress on the students the importance of handling these expensive and delicate instruments with care.
3. Show the students how to carry a microscope safely: using 2 hands, without jarring the instrument, and with the objective lenses out of line.
4. Organize a systematic distribution of microscopes and supervise the procedure actively.
5. You may want to go through this activity with the class step-by-step.
6. As the students are getting familiar with their microscopes, circulate and help individual students with their difficulties, which will be many.
7. In Step B, to avoid breaking the cover slip, apply equal pressure on both sides. Plastic cover slips will eliminate the problem.
8. In Step C the printed letter "e" is used because it is easily identified as reversed or upside down.
9. In Step D the paper will stick to the dropper.
10. Step J might alternatively have shown a microscope with built-in lamp, or a large central lamp for use with several microscopes.
11. In Step P, keeping the clips on the slide gives better control of movement.
12. Students will try to look at their hands through the microscope. Explain that because the hand is not transparent, a different technique—reflected light—must be used. (This technique is illustrated in "Action Biology," *Keeping Alive,* Chapter 7.)

ANSWERS TO QUESTIONS

1. See the table below for the answer.
2. There may be some variation from functions given in the following table.

MICROSCOPE WORKSHEET

How The Microscope Works

Name of Part	*Part Number*	*Function of Part*
Eyepiece	1	Helps magnify object; eye looks through it.
Body Tube	2	Holds eyepiece and nosepiece; keeps out unwanted light.
Nosepiece	6	Holds high power and low power lenses.
High Power Lens	8	For high magnification.
Low Power Lens	7	For low magnification.
Clips	9	Holds slide in place on stage.
Stage	11	Holds slide; lets light shine through slide.
Diaphragm	10	Controls amount of light in microscope.
Mirror	12	Shines light into microscope.
Base	13	Supports microscope.
Coarse adjustment knob	3	For coarse focusing.
Fine adjustment knob	4	For sharp or fine focusing.
Arm	5	Holds body tube; used to carry microscope.

3. It is upside down, and reversed left to right ("ə").
4. The paper has many thick-looking, interwoven fibers.
5. The object seems to move in the opposite direction.
6. A printed photograph is made of many dots of different sizes.

2 HIGH POWER OPERATOR Pages (7) 135 - (10) 138

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe the function of a microscope.
b. contrast electron and light microscopes.
c. identify high power and low power microscope objective lenses.
d. find under high power any point in a low power microscope field.
e. determine when a microscope is parfocal.
f. properly adjust the light in a microscope.
g. contrast the microscopic appearance of lens paper under low and high power.
h. calculate the total magnification of a compound microscope.
i. describe the microscopic appearance of several different materials or objects.
j. contrast correct and incorrect procedures for using a microscope.

TEACHING TIPS

1. Along with Chapter 1, Chapter 2 should be taught before any further microscope work, whether from *The Invisible World* or from other units of "Action Biology."
2. After reading the introductory material, have students describe the function of a microscope, and briefly contrast light and electron microscopes.
3. Section B, HOW MUCH DOES IT MAGNIFY?, relates microscopy to mathematics. If it seems advisable, this work may be extended—for example, by asking students to determine how much more powerful an electron microscope (e.g., 1,000,000×) is than their own microscopes.
4. Section C is an extension of the activity. Do as much of this work as time and student interest allow. Distribute to each group beakers and droppers for glycerin and alcohol. Label the beakers. Any kind of alcohol may be used, but denatured ethyl and isopropyl, the latter often sold as rubbing alcohol, are cheapest and most available. Microfossils and cultures of brine shrimp and rotifers may be purchased from biological supply houses. Microfossils may be purchased cheaply as diatomaceous earth from most tropical or petfish stores. Cultures of many living animals are easily maintained. Table salt, Epsom salt, granulated sugar, and tartaric acid each has a distinctive crystal structure that is visible under the microscope. Starch granules are also distinctive. Tartaric acid is sold in drug-stores.
5. Treat the MICROSCOPE DO'S AND DON'T'S WORKSHEET as a puzzle. First let students work out their own solutions, which they may or may not write out. Then conduct

a class discussion—which may become quite animated. The discussion will serve as a summary and review of microscope technique.

HIGH POWER ACTIVITY

Materials (per student or per pair of students)

- compound microscope
- microscope lamp
- slides
- cover slips
- lens paper
- dissecting needle
- scissors

EXPLORING THE INVISIBLE WORLD, page (9) 137 (per group of 4 or 6)

- beaker of water
- beaker of glycerin
- beaker of alcohol
- 3 droppers
- table salt, granulated sugar, tartaric acid, Epsom salt, corn starch
- microfossils (diatoms)
- dish of nylon bristles (nylon paint brush)
- culture of brine shrimp or rotifers
- wool, cotton, synthetic fibers or fabric

Notes on the Activity

1. This activity continues the instruction in basic microscopic technique begun in *The Invisible World*, Chapter 1, Microscope Activity.
2. For directions for Step B, see *The Invisible World*, Chapter 1, Microscope Activity.
3. When a parfocal microscope is focused using 1 of its objective lenses, a second objective lens that is switched in line will also be in focus without requiring further coarse adjustment. To answer students' questions in Step E, microscopes will have to be checked beforehand for parfocality, and marked. A student with a parfocal microscope can go from Step E directly to Step H. If the microscope is not parfocal, the student must go through Steps F and G.

ANSWERS TO QUESTIONS

1. Many interwoven fibers.
2. Because the high power objective lens is smaller than the low power lens and covers a smaller area. Therefore only objects in the central part of the low power field will appear in the high power field.
3. Because the high power lens is small and lets in enough light only if the light is bright.
4. Under high power the paper fibers look much bigger. You see fewer of them.
5. The fibers get sharp and then fuzzy; they go in and out of focus.

B. HOW MUCH DOES IT MAGNIFY?

Total magnification of student microscopes will vary. With the most commonly used school microscopes answers will be as follows:

Microscope Magnification

Eyepiece Magnification	×	*Object Lens Magnification*	=	*Total Magnification of Microscope*
10×	×	10×	=	100× (low power)
10×	×	43×	=	430× (high power)

MICROSCOPE DO'S AND DON'T'S WORKSHEET

Do	*Don't*
1. Carry microscope carefully with 2 hands.	Carry microscope carelessly with 1 hand.
2. Place arm facing toward you.	Place arm facing away from you. (Research models, or student models with built-in lamps, may be used in this position.)
3. Keep body tube erect with wet-mount slide.	Tilt body tube with wet-mount slide. (Research models have tilted eyepieces.)
4. Focus up only with high power.	Focus down with high power.
5. Wipe lenses with clean lens tissue.	Wipe lenses with handkerchief.
6. Place microscope squarely on table.	Place microscope at edge of table.

3 FINGERPRINT EXPERT Pages (11) 139 - (14) 142

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe the various responsibilities of the police.
b. describe the work of a crime laboratory.
c. describe characteristics of the skin that produce fingerprints.
d. classify fingerprint patterns as whorl, loop, or arch.
e. record fingerprints.
f. recognize microscopic characteristics of various hair types.
g. identify "evidence" such as fingerprints and hair types.

TEACHING TIPS

1. The text provides material for discussion of career opportunities in the field of law enforcement. Ask students to describe what the police are doing in each of the pictures in this chapter, and to describe the work of a police crime laboratory.
2. Students will accept the opportunity to evaluate "evidence of crime" as an interesting challenge. But in the discussion, stress the dangers—both scientific and legal—of drawing over-enthusiastic and too far-reaching conclusions from scanty evidence.
3. Ask the students to describe the characteristics of the skin that produce fingerprints and how fingerprint patterns are classified.

MICROSCOPIC EVIDENCE ACTIVITY

Materials (per pair of students)
- compound microscope
- microscope lamp
- magnifier
- gooseneck lamp

(per group of 4 or 6)
- paper towels
- lens paper
- slides
- dish of soapy water
- dispenser of talcum powder
- black, brown, red, blonde, gray, dyed and bleached hairs
- glycerin
- beaker and dropper
- stamp pad (optional)

(per class)
- envelopes of "evidence of crime" (1 envelope per student)

Notes on the Activity

1. After Step A rinse the soapy water from the slide before drying it.
2. In Step C oily fingerprints will show up best on a clean slide.
3. OPTIONAL: For permanent prints, press the fingers on an ink pad and then on a sheet of paper.
4. In Step H a gooseneck or desk lamp should be shone on the finger from above.
5. In Step I the eyebrow hair is thinner.
6. In Step K the envelopes might include fingerprints, hairs, and any materials previously observed with the microscope (e.g., sugar, salts, cloth fibers, nylon bristles, or paper). Write a sentence on the envelope describing the crime and where the evidence was collected.
7. In discussion of Steps K and L, students will be interested in inferring data from the "evidence." For example, sugar and salt might suggest that a kitchen or restaurant was the scene of the "crime."

ANSWERS TO QUESTIONS

1. The color is found in the outer layer of the hair shaft.
2. Answers will vary.

B. THE POLICE AT THE MICROSCOPE. On page (12) 140 the bullets on the left side and the middle of the photograph were fired from the same gun.

4 WHAT WE ARE MADE OF Pages (15) 143 - (18) 146

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. make stained slides of simple animal cell

preparations such as cheek scrapings, shed frog skin, and ground meat.

b. identify 3 basic structures in a typical animal cell (nucleus, cytoplasm, and cell membrane) and describe the function of each structure.

c. prepare a labelled drawing of a cheek cell.

d. compare frog and human cheek cells.

e. use prepared animal tissue slides to compare cheek cells with other cell types.

f. state the cell theory.

g. describe results and draw conclusions from an experiment comparing half-amebas with and without nuclei.

h. list the ways in which all cells are alike.

TEACHING TIPS

1. The "WE" in the chapter title refers to man's cellular similarity to other animals.

2. This chapter introduces the cell theory as applied to animals—that animals are composed of cells which are basically alike in structure and function—without using the term "cell theory." Sections A and B present the concept. Discuss the theory; illustrate it with films, charts, models of cells, and other audiovisual aids. Ask students to define the cell theory. In Chapter 5 the cell theory is extended to plants.

3. Dr. Ernest E. Just was a distinguished embryologist who worked at Howard University and at the Marine Biological Laboratory on Cape Cod. His special field of investigation was the relationship between nucleus and cytoplasm.

4. In teaching Section B, stress the 3 structures generally found in cells—nucleus, cytoplasm, cell membrane.

5. Section C describes an experiment substantiating the vital role of the nucleus in the life of the cell. Note that not all control half-amebas (with nuclei) remained alive. The important result is the great difference between survival rates of control and experimental half-amebas (without nuclei). Stress that our ideas concerning the importance of the nucleus are based on such experiments, not simply on somebody's opinion. This is how science works.

6. Section D emphasizes differences among the major tissue cell types in the body. Each cell type is adapted for its particular functions. In discussing this section, draw on the students' observations in Step K of the activity.

7. In discussing Section E, stress the minute, microscopic size of most cells. Egg cells (the largest) and nerve cells (the longest) are exceptions.

ANIMAL CELL ACTIVITY

Materials (per student or per pair of students)
- microscope
- microscope lamp
- slides
- cover slips
- dissecting needle
- lens tissue
- dropper bottle of stain (Lugol's iodine or methylene blue)

(per group of 4 or 6)
- sample of raw ground beef
- jar of flat toothpicks

(per class)
- frog in an aquarium of shallow water
- selection of stained animal tissue slides (for example, epithelium, cartilage, liver, intestine cross section, sponge, hydra cross section)
- dropper

Preparation of Materials

1. To prepare a stock solution of Lugol's iodine dissolve 10 g potassium iodide in 100 ml of distilled water; then add 5 g iodine. For use as a stain, dilute 1 part of the stock to 10 parts of water. Store in dark or aluminum foil covered bottles. Lugol's iodine solution can also be purchased in prepared form.

2. To prepare a 1% solution of methylene blue stain, dissolve 1 g methylene blue powder in 100 ml of distilled water. If the stain is too dark, add more water.

Notes on the Activity

1. This activity may take several lab periods to complete. Students may draw each cell type they observe.

2. In Step B caution students not to use the pointed end of the toothpick and to scrape gently.

3. In Step E air bubbles from saliva may appear on the slide and confuse the student.

4. In Step I keep the water in the aquarium shallow. Small scraps of shed skin will cloud the water. Use a dropper to obtain the water.

5. In Step J students will tend to take too large a sample of meat. Use a piece not much larger than a pinhead, and spread it well in 1 or 2 drops of stain. Look for long, thin muscle cells, large round fat cells, small red blood cells, and fibrous connective tissue cells.

6. In Step K make available an assortment of tissue slides which show large, well defined cells; the list of materials makes several suggestions.

7. To guard against TB and other infections, immediately discard toothpicks in a covered container. Boil or autoclave all glassware.

ANSWERS TO QUESTIONS

1. Flat, roughly oval or square with irregular borders. Neighboring cells are closely fitted together.

2. The cheek cells are very much larger.
3. They are the same shape but frog skin cells are larger and their nuclei are larger.
4. The muscle tissue of the cow or pig from which the ground meat came.
5. They all have nuclei, cytoplasm, and cell membranes.
6. Answers will vary. Different kinds of cells may be arranged differently, they may differ in size, or shape, and they may contain various special structures.
7. Some of the half-amebas with nuclei died, but most survived past the 20th day, and by the 40th day they began increasing in number as a result of reproduction. Beginning with the 3rd day the half-amebas without nuclei died faster than those with nuclei, and by the 20th day none of the former were left alive.
8. A half-ameba can stay alive for only a short period of time without its nucleus. Ameba needs its nucleus to stay alive and to reproduce.
9. All cells are parts of living things. All cells contain the same basic structures—nucleus, cytoplasm, and cell membrane.

5 WHAT PLANTS ARE MADE OF Pages (19) 147 - (24) 152

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. tell how Robert Hooke named and discovered cells.
b. state the cell theory.
c. compare plant and animal cells.
d. make simple slides of plant materials, such as cork, onion skin, and elodea leaves.
e. demonstrate the cell membrane and cytoplasmic movement in plant cells.
f. label a diagram of an onion cell and elodea leaf cell.
g. explain the job performed by the various cell parts.

TEACHING TIPS

1. Along with Chapter 4, this chapter develops the concept of the cell theory—that all living things are composed of cells. Have students describe how Robert Hooke named and discovered cells, and state the cell theory.
2. In class discussion stress the basic resemblances among cells, and the structures which all cells have in common—nucleus, cytoplasm, and cell membrane. Also stress the structures unique to plant cells—cell wall, large vacuole, chloroplasts.
3. Hormones, referred to in Section D, are studied in "Action Biology," *Reproduction*, Chapters 5 and 6.
4. Discuss the significance of the contributions of Dr. Percy L. Julian to society. Millions of arthritis sufferers owe their comfort and health to this grandson of a former slave for bringing the price of cortisone within their reach.

PLANT CELL ACTIVITY

Materials (per student or per pair of students)
microscope
microscope lamp
dissecting needle
single-edged razor blade
slides
cover slips
dropper bottle of stain (methylene blue or Lugol's iodine)
dropper bottle of 5% salt water
cork
forceps

(per class)
jar of elodea in water
onions
paper towels
gooseneck lamp

Preparation of Materials

1. See Chapter 4 of the *Teacher's Guide* for the preparation of the stains.
2. To prepare 5% salt water dissolve 5 g sodium chloride into 100 ml of water.

Notes on the Activity

1. This activity may take several laboratory periods to complete. Elodea can be purchased from a tropical pet fish store.
2. In Step A the slice of cork must be thin enough to be transparent. Usually the edge of the slice of cork is thin enough.
3. In Step E the square of onion skin should be handled carefully so that it does not wrinkle.
4. In Step F use a general stain such as Lugol's iodine or methylene blue.
5. In Step G dimming the light will help to make the vacuole visible. All structures should be visible except the cell membrane which will probably not become apparent until Step N.
6. In Step J the warmth and the light will often cause the cytoplasm to start circulating within the cells, especially those of the young leaf.
7. In Step N the protoplasm has shrunk away from the cell membrane, which can be seen inside the cell wall.
8. In Step O the chloroplasts are moving around the outer part of the cell. The cytoplasm is moving.

PLANT CELL WORKSHEET

Parts of Plant Cells

Part Number	*Onion cell*	*Elodea cell*
1	cell wall	chloroplast
2	cell membrane	vacuole
3	nucleus	cytoplasm
4	large vacuole	nucleus
5	cytoplasm	cell membrane
6		cell wall

Table of Cell Parts

Cell Part	*Check if Present in Cells of:* *Animal*	*Cork*	*Onion*	*Elodea*	*What Job Does the Part Do?*
Nucleus	√		√	√	Helps cell keep alive and reproduce.
Cytoplasm	√		√	√	Does work of cell.
Cell membrane	√		√	√	Keeps cell together; lets things pass through.
Large vacuole			√	√	Holds water; keeps cell plump; supports.
Chloroplast				√	Makes cell green, *or* makes food.
Cell wall		√	√	√	Protects cell; holds it together.

ANSWERS TO QUESTIONS

1. Cell wall, chloroplasts, large vacuole.
2. The elodea cell was green because of its chloroplasts. Onion cell has a large central vacuole.
3. It made the protoplasm shrink because it drew water out of the cell.
4. They moved around the outer part of the cytoplasm, all in the same direction. They did not go outside the cell to another cell.

6 SLIPPER HUNT Pages (25) 153 - (26) 154

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. state the difference between protozoa and other animals.
b. discuss the life activities of protozoa.
c. describe paramecium.
d. prepare and examine a microscope slide of living paramecium.
e. identify and label a drawing of cell structures in paramecium.

TEACHING TIPS

1. Chapters 6 and 7 deal with the interesting topic of protozoa. Chapter 6 stresses a detailed study of paramecium.
2. Although paramecium is here considered a unicellular organism, it is equal in complexity to many multicellular animals. In Section A call attention to the many life activities a paramecium must perform—the same activities that we carry out. Section B summarizes those specific activities of paramecium which students will see.
3. A student is unlikely to see all possible structures in a living paramecium. Therefore you may want to supplement the Paramecium Activity, which uses living protozoa, with other materials, such as stained slides, charts, films, or transparencies.
4. To observe reproduction and functioning vacuoles in living paramecia requires much patience and some luck. When students succeed in making these observations, call this to the class's attention. The successful students will get a big ego boost.
5. In your post-activity discussion ask students to give the definition of protozoa, and to list the life activities of paramecium and contrast them with human life activities.

PARAMECIUM ACTIVITY

Materials (per student or per pair of students)
- microscope
- microscope lamp
- slide
- cover slip
- dissecting needle
- lens paper

(per group of 4 or 6)
- paramecium culture
- threads
- dropper bottle of 5% methocel (methyl cellulose) solution
- dropper bottle of Congo red stain

Preparation of Materials

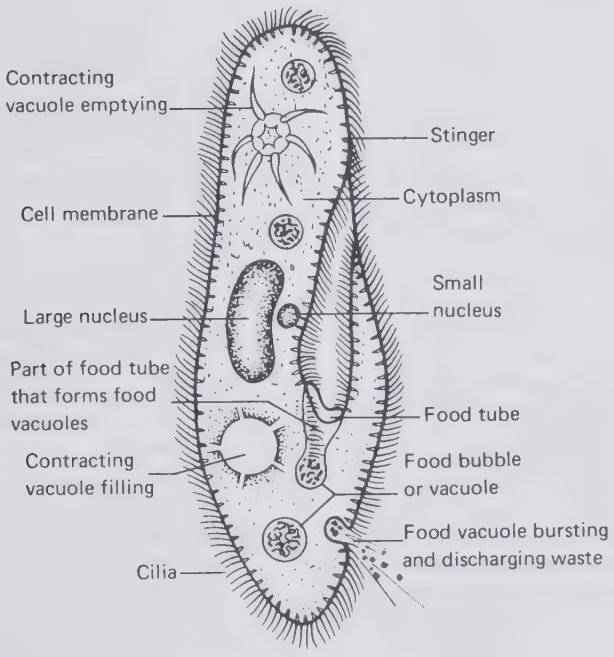
1. To prepare a 1% solution of Congo red stain, add 1 g Congo red powder to 100 ml of distilled water. If stain is too dark, dilute with more water.
2. To prepare a 5% methyl cellulose (methocel) solution, dissolve 5 g methyl cellulose into 100 ml of warm distilled water. Prepared solutions can be purchased from a biological supply house.

Notes on the Activity

1. Paramecia may be cultured, or cultures may be purchased from biological supply houses.
2. In Step A nylon threads, sewing cotton, or a scrap of lens tissue may be used to slow down the paramecia. A 5% solution of methyl cellulose (or methocel) in water also helps. The Congo red is a 1% solution in water. While not a food, the Congo red is ingested along with food, and helps to trace the path of the food vacuole.
3. In Step D the student can follow a swimming paramecium by using his thumbs to move the slide on the microscope stage and under the clips. Make this slightly tricky procedure a challenge to the students.
4. In Step E the microscope diaphragm must be manipulated in order to adjust the light for best observation.

ANSWERS TO QUESTIONS

1. It is shaped like the sole of a slipper.
2. The "heel." It generally goes first.
3. The cilia sweep water containing food particles down a food tube into the paramecium. At the end of the tube the particles are squeezed together. A bubble forms around them and breaks off from the tube and travels through the cell.
4. Answers will vary, e.g., moving, eating, getting rid of water.
5. All structures need not be named. Let students identify as many as they can.



7 THE LITTLEST ANIMALS Pages (27) 155 - (32) 160

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. recognize various protozoa.
b. prepare slides of living microscopic animals.
c. observe protozoa microscopically, and describe them.
d. describe some of the characteristics,

structures, and behavior of ameba and euglena.
e. tell why euglena is a plant-animal.
f. describe how rotifers move.
g. compare asexual reproduction in ameba, paramecium, and euglena.
h. define asexual reproduction.

TEACHING TIPS

1. Both Chapters 6 and 7 deal with protozoa. Chapter 7 is a broad survey of a variety of protozoa, and leads to understanding some general principles.
2. Not all the protozoa discussed in this chapter must be studied. Select—or encourage the students to select—those forms that are available, that seem most interesting, and that time allows for.
3. In Section B euglena illustrates the point that there is no sharp line between plants and animals.
4. In Section C vorticella often grows abundantly in polluted water and is an indicator of the stage of pollution. (See "Action Biology," *Ecology*, Chapter 12.)
5. In Section F you may wish to develop the notion of asexual reproduction as a major concept that may be generalized from this chapter. Discussing the questions will help do this.

PROTOZOA ACTIVITY

Materials (per student or per pair of students)

microscope	cover slips
microscope lamp	dissecting needle
slides	lens paper

(per group of 4 or 6)
binocular dissecting microscope
cultures of various protozoa: ameba, euglena, mixed protozoa, vorticella, rotifers
permanent stained slides of protozoa
dropper bottle of 5% methocel solution
dropper bottle of Congo red
jar of Vaseline
toothpicks
nylon bristles

Preparation of Materials
See *Teacher's Guide, The Invisible World*, Chapter 6, for the preparation of the 5% methocel (methyl cellulose) solution and the Congo red stain.

Notes on the Activity
1. This activity may take several laboratory periods to complete. Note that it is not necessary for the student to observe all the organisms in the activity.
2. Protozoa cultures may be purchased or, except for ameba, cultured in the classroom.
3. In Step C make the Vaseline ring as thin as possible. Instead of Vaseline you may want to use a nongreasy soft wax, obtainable from biological supply houses.
4. For Step D clip nylon bristles from cheap paint brushes.
5. In Step G, if the culture dish is left undisturbed, amebas will congregate on the bottom. With the naked eye they may be seen as small whitish dots. Under a dissecting microscope they may be picked up individually with a dropper.
6. Rotifers are likely to be abundant in old protozoa cultures—where they are a nuisance—or in aquarium or pond water.

ANSWERS TO QUESTIONS

(Students should answer only those questions that deal with organisms they have observed or discussed in class.)
1. It changed shape.
2. It is attracted to the light.
3. They break loose from their attachment and swim away.
4. Cilia sweep water currents into the "mouth." Food particles are taken into a food tube where they seem to be ground up.
5. It changes shape. It stretches out part of its body, false feet, and flows into these parts.
6. It flows around the food and forms a food vacuole.
7. It swells and shrinks. It pumps water out of the cell.
8. See figure of ameba page (29) 157.
9. It moves like most animals do, but it is green like most plants.
10. It swims by beating its long hair or flagellum.
11. See figure of euglena, page (30) 158.
12. They can swim head first or walk by stretching, attaching, and somersaulting.
13. They have cilia. They are one-celled.
14. It has only 1 parent.
15. Two.
16. Same way except that euglena splits down the length instead of across the middle.
17. It turns into its children.
18. Because each offspring is part of the original parent.

8 SOURDOUGH Pages (33) 161 - (36) 164

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. recognize that a sourdough starter is composed of living yeast cells.
b. run several simultaneous experiments.
c. use controls in an experiment.
d. prepare and observe slides of living and stained yeast cells.
e. draw a stained yeast cell.
f. perform and interpret the limewater test for carbon dioxide.
g. explain the concept of fermentation by yeast.
h. explain the concept of asexual reproduction in yeast by means of budding.
i. list some useful products of fermentation.
j. list some vocational opportunities in fermentation industries.

TEACHING TIPS

1. A brief discussion of sourdoughs and their use of yeast starters will introduce the subject of fermentation by yeast and other microorganisms.
2. In discussing yeast reproduction by budding, you may want to refer also to asexual reproduction by fission in protozoa, presented in Chapter 7.
3. Section C relates fermentation to consumer products and to vocational opportunities.

YEAST ACTIVITY

Materials (per pair of students)

microscope	dissecting needle
microscope lamp	lens paper
slide	marker
cover slip	3 small test tubes
dropper	2 vials
bottle of yeast starter	
bottle of 5% sugar water	
dropper bottle of Lugol's iodine	
bottle of limewater	

Preparation of Materials

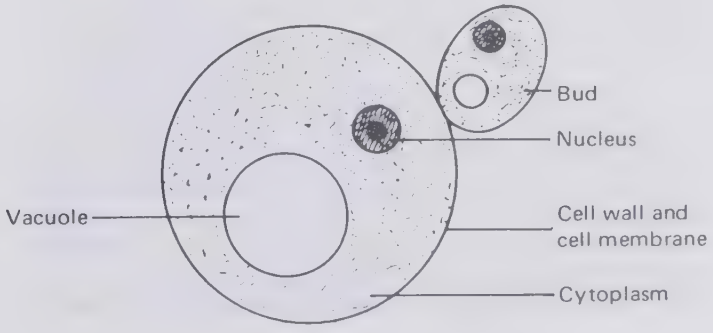
1. See *Teacher's Guide, The Invisible World,* Chapter 4, for the preparation of Lugol's iodine solution.
2. To prepare 5% sugar water (glucose solution) dissolve 50 g glucose in 1 liter of water.
3. To prepare the starter, mix half a cake of commercial baker's yeast in 500 ml of 5% glucose solution. Incubate overnight in a warm place at approximately 30° C (86° F).
4. Alternatively, prepare the starter by mixing 1 package of dry yeast in 500 ml of water to which 125 g brown sugar has been dissolved. Incubate overnight in a warm place. If you use this procedure, prepare the sugar water by dissolving 250 g brown sugar in 1 liter of water.
5. To prepare limewater, slowly add calcium oxide to a liter (or gallon jar) of water, mixing and shaking continuously, until no more will dissolve. Allow the excess calcium oxide to settle to the bottom of the container for 24 hours. Use only the clear supernatant (limewater) and keep it well stoppered.

Notes on the Activity

1. For Steps E and F use shell vials or drug-store vials slightly wider than the test tubes, so that the inverted test tubes will stand upright. If necessary, support the vials in tin cans, beakers, or baby food jars.
2. In Step G, initially there will probably be an air bubble at the top of each tube. In the experimental ("E") tube the gas-filled space will increase steadily, while in the control ("C") tube it will remain the same size.
3. In Steps M and N the liquid will flow out, but if the thumb is applied quickly, the gas will be retained.

ANSWER TO QUESTIONS

1. The starter bottle has a yeasty smell. Alcohol.
2. As you watch, the buds slowly grow. Cell walls cut them off, but the buds stay attached to the mother cells. Sometimes new buds grow on older buds.
3.



4. In the "E" tube the liquid moved down and out of the tube. The gas bubble at the top became bigger. Nothing happened in the "C" tube.
5. The "E" tube.
6. From the yeast, or from the yeast and sugar water.
7. That sugar water alone doesn't produce carbon dioxide.
8. By growing buds, or asexually.
9. Asexual.
10. Bread, pickles, wine, cheese.
11. Baking, pickle making, wine making, cheese making.

9 A MOLDY STORY Pages (37) 165 - (40) 168

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe some economically useful activities of molds.
b. describe some economically harmful activities of molds.
c. start a bread mold culture.
d. observe bread mold without a microscope.
e. prepare slides of bread mold.
f. identify structures in the bread mold mycelium.
g. tell the effect of refrigeration on mold life cycle.
h. define installment, or credit buying.
i. calculate the cost of installment buying.
j. evaluate the economics of credit buying.

TEACHING TIPS

1. Using bread mold as the laboratory example, this chapter provides a broad survey of the ecological and economic importance of molds and fungi. Begin the lesson by having students cite some of their experiences with molds. These experiences should include both useful and harmful activities of molds.
2. Bring mold specimens into the classroom —Roquefort cheese, blue cheese, moldy food, moldy or musty clothing, molds found in rotting wood or elsewhere in nature. Moldy fruit can be obtained from large food stores. For an unassorted culture of molds, rub orange skins, apple slices, raw potato slices, or pumpkin slices across a dusty surface. Place each in a tightly covered container (tightly sealed plastic sandwich bag or baby food jar) with a few drops of water. Keep moist and in the dark. Mold will appear within a week.
3. In Section B, students may be interested in some of the uses of molds. In Roquefort cheese the mold is very visible. Green Penicillium mold may develop, along with bread mold, on the students' bread samples.
4. Sections C and D relate the study of molds to consumer issues. THE BUYING-ON-CREDIT WORKSHEET, a math activity, may be expanded with additional spontaneous examples, including credit contracts of the students' families.

GROWING-MOLDS ACTIVITY

Materials (per student or per pair of students)
- baby food jars with lids
- clear plastic sandwich bags
- Scotch tape
- labels or markers
- stale bread with no preservatives
- microscope
- microscope lamp
- slides
- cover slips
- dissecting needle
- forceps
- lens paper

(per group of 4 or 6)
- binocular dissecting microscope
- 70% alcohol (cheapest)
- bread mold culture
- jar of Lysol disinfectant

Notes on the Activity

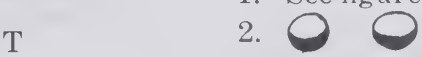
1. Four to 7 days before the activity have the students set up their bread mold cultures at home or in school. Containers such as baby food jars with lids, Petri dishes, or clear plastic sandwich bags sealed (air tight) with Scotch tape may be used. Cultures should be kept in a warm, dark place.
2. Bread baked with propionate to retard molds obviously cannot be used to grow a bread mold culture. Use a bread without preservatives. Locally baked rather than nationally distributed bread is most likely to be free of mold retardant. Older, stale bread gives better results than fresh bread. If you have the students set up cultures at home, you can expect some, but not all, students in any class to succeed in growing bread mold, and to bring it to school. To insure that you have cultures to use, grow some yourself.
3. Since some students are allergic to mold spores, care should be taken that the spores are not excessively distributed throughout the room. Students should *not* touch molds. Cultures can be examined in closed dishes.

4. In Step K students should prepare slides from good black bread mold cultures. The bread mold should be handled with forceps.
5. At the end of the activity, discard all cultures in closed containers, since some cultures may contain harmful molds. Soak used slides, cover slips and glassware in a strong Lysol solution before washing.

BUYING-ON-CREDIT WORKSHEET

1. Buying now, paying later.
2. ($9.82 × 24) − $218.04 = $235.68 − $218.04 = $17.64 more.
3. ($17.21 × 24) − $350 = $413.04 − $350 = $63.04 cost of credit.
4. Yes, because they have sold their product and paid for it, but they haven't received their money back yet. They may have to borrow from the bank to meet expenses. But the cost of credit may also hide unreasonable profits.

ANSWERS TO QUESTIONS

1. See figure Step J, page (39) 167.
2. 
3. They would scatter through the air.
4. To get some spores.
5. Some of my spores will last until next year.
6. They make spores that can grow into new mold plants.

10 BEAN SOUP Pages (41) 169 - (44) 172

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. generalize concerning the occurrence of bacteria.
b. tell that bacteria are simple, single cells.
c. recognize the 3 forms of bacteria.
d. define the term sterilize.
e. describe 2 ways of killing bacteria.
f. examine live bacteria.
g. prepare, stain, and examine a bacterial smear.
h. apply sterile and disinfection techniques in handling bacteria.

TEACHING TIPS

1. In discussing the introductory paragraphs and Section A, stress the universal occurrence of bacteria, and the harmlessness of most of them. Begin by asking where bacteria are found.
2. The concept of sterility is referred to in Section C and then applied in the activity.

BEAN SOUP ACTIVITY

Materials (per student or per pair of students)
microscope with high power 43× objective
microscope lamp
slides
cover slips
dissecting needle
transfer loop
lens paper
paper towels
beaker
staining dish
Bunsen burner
dropper bottle of bacterial stain (methylene blue or safranine)
jar of water for rinsing

(per group)
jar of bean soup
jar of clear soup
jar of Lysol disinfectant

Preparation of Materials

1. See *Teacher's Guide, The Invisible World,* Chapter 4, for the preparation of methylene blue stain.
2. To prepare safranine stain, add 0.25 g safranine to 10 ml of 95% ethyl alcohol and then add 100 ml of distilled water.
3. Most stains are available as a powder or prepared solution from biological supply houses.

Notes on the Activity

1. To prepare the bean soup, lightly mash half a dozen beans and place them in a jar of water at room temperature for 48 hours. A rich bacterial growth will develop.
2. CAUTION: Although most of the bacteria in the bean culture are harmless, care must be taken to use sterile techniques throughout this activity.
3. In Step C start flaming the transfer loop near the handle. When this section becomes red hot, move toward the loop, which should be the last section flamed. Stress that the loop must be flamed immediately after each use.
4. In Step E the edge of the cover slip should bisect the low power field, and should also be

visible in the high power field when lenses are switched. The purpose of focusing first on the edge of the cover slip is for orientation to the level of the bacteria, which otherwise will be hard to find.

5. In Step F, if the light is made too bright, the bacteria will not be visible.

6. In Step J to make a good smear use *clean* slides free from grease. If necessary, wash slides in soapy water and rinse well.

7. In Step K safety precautions must be taken with the use of the Bunsen burner. For example, long hair should be tied back and sleeves rolled up. Smear should be air dried before it is flamed. To stick the bacteria to the slide pass it through the flame 3 or 4 times. Caution students not to overheat the slide. They should be able to place the warm slide on the back of their hand without flinching.

8. In Step L, if the bacteria are not stained dark enough, increase staining time.

9. In Step M gently rinse the slide by dipping it 1 or 2 times in the jar of water.

10. In Step N do not rub the slide, but gently blot it dry with paper towelling. Then allow it to air dry.

11. In Step O use high power. An oil immersion lens is better but is not essential.

12. CAUTION: At the end of the activity, disinfect for 24 hours in a strong Lysol solution all discarded glassware, including slides, that have been in contact with bacteria. This precaution is essential because disease-causing forms may be present.

ANSWERS TO QUESTIONS

1. The soup looked cloudy. It smelled rotten.
2. To kill the bacteria on it.
3. Yes, they can move. They swim through the water with a weaving movement, *or* they swim with their flagella.
4. With a flame or with disinfectant.
5. It is cloudy, it smells bad, and you can see the bacteria with a microscope.
6. Answers will vary. Probably all 3 basic shapes will be observed.

11 THE GOOD GUYS Pages (45) 173 - (48) 176

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. recognize that most bacteria are harmless or useful to people.
b. organize data on useful functions of bacteria.
c. make sauerkraut.
d. make yogurt.
e. find and identify microorganisms in sauerkraut and yogurt.

TEACHING TIPS

1. By citing many concrete examples of useful bacteria, this chapter and the activity focus on counteracting the widespread notion that all bacteria are harmful.

2. Sewage disposal is also presented in "Action Biology," *Ecology,* Chapter 14.

3. Illustrate Sections B and C by bringing in examples of bacterial products. Organize a "Bacterial Minifair" and encourage students to bring in and demonstrate additional examples. Demonstrate the bacterial nodules on clover roots. Acetone, the basic component of nail polish remover, is a product of bacterial fermentation. Bacteria rot the sisal and jute plants and loosen the fibers used to make rope. A lactobacillus produces the special flavor of San Francisco sourdough bread. (See also Chapter 8.)

4. After brief group discussions of question 1, have the groups join in a class discussion. List on the chalkboard student suggestions of some of the useful activities of bacteria.

GOOD-GUYS ACTIVITY

Materials (per group)

2 baby food jars or drugstore pill vials
knife and board
measuring cup
large jar or beaker for mixing
spoons
microscope
slide
bacterial stain (See *Teacher's Guide, The Invisible World,* Chapter 10.)
staining dish
cabbage
unpasteurized sauerkraut or sauerkraut juice
powdered milk
plain yogurt
soap
paper towels
transfer loop or dropper
Bunsen burner
jar of water
incubator (helpful)

Notes on the Activity

1. For sauerkraut and yogurt preparation, use baby food jars or small, drugstore plastic pill vials.
2. In Step A to save time shred the cabbage in advance. Fill the clean jar *as completely as possible* with cabbage.
3. In Step B use distilled or boiled water and fill the jar completely. Add a few drops of unpasteurized sauerkraut juice to hasten the fermentation process.
4. In Step C shake the jar around a bit to dislodge air bubbles and add more water if necessary. Lactic acid bacteria grow in anaerobic environments.
5. In Step E the water should be just *warm* to the touch.
6. In Step F the starter is a sample of unpasteurized plain yogurt.
7. In Step G, if an incubator is not available, place the jar near a radiator or in any warm area of the room. If you are able to keep the temperature nearer to 110° F than 90° F the yogurt will set more quickly. If it does not set within 5 hours, your temperature is probably too low and you are making sour milk. Pick up a jar and shake gently to see if yogurt is setting. Do not stir! Refrigerate when yogurt is firm.
8. Although it is probably safe to taste sauerkraut and yogurt that smells clean (no off odor), it is advisable that students do not taste their products.
9. Dispose of rotten or putrid sauerkraut in a safe fashion.
10. For Steps J and K refer students to *The Invisible World,* Chapter 10 for the proper technique. Students should report their observations orally or with drawings.

ANSWER TO QUESTIONS

1. Answers will vary. Examples of useful bacteria should be cited.
2. So that the wrong kinds of bacteria won't get into the yogurt and spoil it.
3. A sample of yogurt that contains the right bacteria.
4. Sauerkraut juice with the right kind of bacteria.
5. Answers will vary.
6. Answers will vary.

12 THE BAD GUYS Pages (49) 177 - (52) 180

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. recognize some harmful effects of bacteria other than disease.
b. summarize the conditions that bacteria need for survival.
c. correlate conditions that bacteria need with methods for controlling bacteria.
d. calculate geometrical growth of bacteria.
e. graph data from a table.
f. interpret a bacterial growth curve.
g. explain how milk sours.
h. justify the pasteurization of milk.
i. use the methylene blue test to determine the condition of milk samples.

TEACHING TIPS

1. This chapter deals with the control of harmful bacteria other than those that produce disease. Through reading and discussion, develop the concept that we basically control harmful bacteria by removing the conditions they need to grow.
2. pH is a chemical value that refers roughly to acid or basic activity. The subject is discussed in "Action Biology," *Food,* Chapter 5, and in "Action Biology," *Keeping Alive,* Chapter 4.
3. The REPRODUCTION OF BACTERIA WORKSHEET introduces the mathematics of growth and graphing in relation to bacteria. If interest allows, you can make up additional examples.
4. In Section C, relate pasteurization to the bacterial growth curve the students have already interpreted.
5. Use Section E to prepare for the Milk-Testing Activity. A little drill will help instill the tricky concept that fresh milk contains a large amount of oxygen which retains the methylene blue color; in spoiled milk, bacteria have used up the oxygen, and the blue color fades. Therefore the faster the color fades, the poorer the quality of the milk.

MILK-TESTING ACTIVITY

Materials (per pair of students)

test tube rack or container
warm water bath or incubator (helpful)
3 test tubes
dropper bottle of methylene blue or methylene blue thiocyanate
mineral oil
dropper

(per group)
marker 3 milk samples

Preparation of Materials
Methylene blue solution can be prepared for this activity in 2 ways. Dissolve 1 methylene blue thiocyanate tablet in 200 ml of distilled water. (Order tablets from Faust Scientific Supply Company, 2081 Industrial Drive, Madison, Wisconsin 53713.) Or, prepare a stock solution by dissolving 1.48 g methylene blue powder in 1000 ml of water and diluting it 1 to 3,000 by adding 1 ml of the stock solution to 3000 ml of water.

Notes on the Activity
1. For Step A obtain a container of definitely soured milk (left at room temperature for several days), a container kept in the refrigerator for several days, and a very fresh container. Label the milk containers A, B and C.
2. Students should label the test tubes with their names and the identity of the milk sample.
3. For Step D incubate the tubes at 37° C in a warm water bath or in an incubator. Alternatively, the tubes may be kept at room temperature, but the results will take a day or so.
4. Students should be able to read their results for the badly contaminated milk during 1 class period. Since several hours may be required for the results from the other milk samples, have students from later classes record the results.

ANSWERS TO QUESTIONS

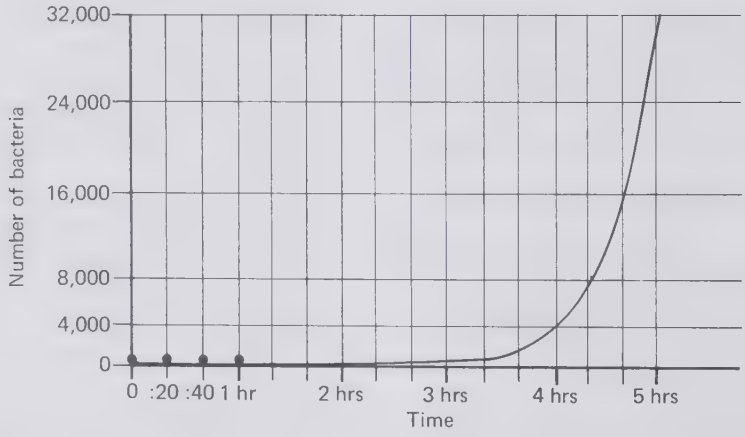
1. To kill disease bacteria.
2. There is lots of oxygen and the milk is fresh.
3. There are few bacteria.
4. Sample will vary. It will be the last to lose color.
5. Sample will vary. It will be the first to lose color.

REPRODUCTION OF BACTERIA WORKSHEET

1. Reproduction of Bacteria in Theory

Time	*Number of Bacteria*
0 hr 00 min	1
0 hr 20 min	2
0 hr 40 min	4
1 hr 00 min	8
1 hr 20 min	16
1 hr 40 min	32
2 hr 00 min	64
2 hr 20 min	128
2 hr 40 min	256
3 hr 00 min	512
3 hr 20 min	1024
3 hr 40 min	2048
4 hr 00 min	4096
4 hr 20 min	8192
4 hr 40 min	16384
5 hr 00 min	32768

2.



3. a. Growth is slow.
b. Growth speeds up.
c. Growth is steady for a while, then slows down and stops, and number of bacteria stays the same.
d. Number stays constant, then drops off. No growth.

13 ACID MOUTH Pages (53) 181 - (56) 184

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .
a. describe a plan for good mouth hygiene.
b. explain the cause of tooth decay.

c. perform, on a slide or in the mouth, the methyl red test for bacteria of tooth decay.
d. demonstrate the effect of brushing the teeth on mouth bacteria.
e. describe vocational opportunities in dentistry and allied dental professions.

TEACHING TIPS

1. By indirection this chapter can be a lesson in personal mouth hygiene. Discuss points of hygiene in general terms, and students will privately apply the points to their own habits.
2. The "sticky, acid coating" referred to in Section A is called plaque. This is where tooth decay is thought to originate.
3. In Section C use the pictures to stimulate interest in vocational opportunities. Discuss the educational requirements for each job.
4. If the students ask about the value of fluoridated toothpastes, use this as a topic for further discussion.

ACID-MOUTH ACTIVITY

Materials (per student)
- toothpicks
- slides
- small paper cup
- toothbrush (Ask students to supply their own.)

(per group of 4)
- dropper bottle of 0.02% methyl red indicator
- plastic spoon
- glucose
- 1% glucose solution
- Q-tip
- mirror
- toothpaste and tooth powder
- materials from *Teacher's Guide, The Invisible World,* Chapter 10, Bean Soup Activity (EXTRA)

Preparation of Materials

1. Prepare a stock solution of methyl red indicator by dissolving 1 g soluble methyl red in 50 ml of distilled water. To prepare a 0.02% solution of methyl red add 1 ml of the stock solution to 99 ml of distilled water. Note that methyl red is yellow above pH 6 and red below pH 4.4.
2. To prepare a 1% glucose solution dissolve 10 g reagent grade glucose in 1000 ml of distilled water.

Notes on the Activity

1. Ask some students not to brush their teeth the morning of the activity and to bring their toothbrush.
2. For hygienic reasons all materials used in this activity should be clean.
3. Stress that each toothpick should be discarded after 1 use.
4. For Step A scrape material from around the base of the teeth.
5. In Step B arrange the material on a glass slide in the shape of a small, 5-mm ring.
6. In Step C the methyl red indicator is placed over and around the ring of material.
7. In Step D place a few crystals of glucose in the liquid in the center of the ring of material.
8. In Step E, in students who have very few acid producing bacteria, the red color may take 1 or 2 hours to appear.
9. In Step G, 2 minutes after rinsing the mouth with 1% glucose, apply methyl red solution with a clean Q-Tip.
10. For Steps H and L provide mirrors, or have girls share their cosmetic mirrors.
11. In Steps I and J, although students have been told in advance, many will forget or neglect to bring toothbrushes, or they may have none. If school policy permits, give or sell toothbrushes; if this is not permitted, make the toothbrush test optional.
12. Alternatively, after washing their hands students can use their index finger as a toothbrush in the TOOTHBRUSH TEST.
13. For Step J provide a small assortment of toothpastes and tooth powder. Dispense in a sanitary manner.
14. For Step K repeat Steps F and G, that is, rinse with glucose solution, wait 2 minutes and then apply methyl red solution.
15. In EXTRA Step M, occasionally large spindle-shaped bacteria, together with corkscrew-shaped spirochetes, may appear on a slide. These organisms are associated with trench mouth, a serious contagious disease. In this situation quietly advise the student to see a dentist, and report the case to the school health authority for follow-up.
16. To guard against TB and other infections, immediately discard toothpicks in a covered container. Boil or autoclave all glassware.

ANSWERS TO QUESTIONS

1. Sugar—acid—bacteria.
2. To give the bacteria something to ferment.
3. It causes decay by attacking the teeth.
4. Answers will vary. Probably the red color took somewhat longer to appear.
5. Answers will vary. Probably the red color took substantially longer to appear.
6. Answers will vary.
7. It removes the sugar that decay-causing bacteria ferment. It may also clean out some of the bacteria.
8. They are likely to have a lot of tooth decay.

14 DO GERMS HAVE PARENTS? Pages (57) 185 - (60) 188

BEHAVIOR OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. grow microorganisms in Petri dish culture.

b. identify and count colonies of microorganisms in Petri dish culture.

c. interpret Spallanzani's and Pasteur's experiments.

d. organize data to decide whether germs must have parents.

TEACHING TIPS

1. This chapter may be used either here or in connection with "Action Biology," *Reproduction.*

2. The question whether germs have parents is 1 phase of the larger scientific problem of spontaneous generation— whether all forms of life must come from life, or may arise spontaneously from nonliving matter. If students raise this larger question, pursue it with the class.

3. Before counting colonies in the Petri Dish Activity, make sure that students understand the rationale of counting colonies to determine how many microorganisms have settled in a dish. The last paragraph in Section A explains this concept.

4. Sections B and C present both sides of the spontaneous generation hypotheses. Let students contribute their own ideas and experiences on this subject. Do not be surprised if some students have very fixed ideas, and do not argue with the students.

5. Analyze Spallanzani's and Pasteur's experiments as contributions, but not as final answers, to the question of spontaneous generation. See note under ANSWER TO QUESTIONS.

6. If student interest suggests this, retain the control dishes from the activity as a further experiment in spontaneous generation. Place the dishes in various conditions of temperature, light, and so on. Do colonies eventually develop? Can you prove that the colonies arose spontaneously?

PETRI DISH ACTIVITY

Materials (per group)

4 to 6 Petri dishes of nutrient agar
cellophane tape
marker
bacterial transfer loop
Bunsen burner
incubator (optional)

Preparation of Materials

1. Prepare Petri dishes containing a thin layer of 3% nutrient agar.

2. Add 30 g nutrient agar to 1 liter of water. In a pot or other vessel, bring it to a boil, stirring constantly. Pour the agar into several (5 or more) clean 250 ml flasks. Cotton plug the mouths of the flasks. Autoclave for 20 minutes at 15 lbs. pressure (121° C).

3. If you are using glass Petri dishes, wrap or place in a special metal can and autoclave them also.

4. Pour a thin layer of hot agar into sterile plastic Petri dishes or autoclaved glass Petri dishes. When pouring the agar plates, work quickly, tilt to spread evenly, and raise the cover of the Petri dish just enough to allow pouring.

5. If the agar gels in the flask, heat in boiling water until it melts.

6. After the agar plates have cooled, turn them over and store in the refrigerator. They will keep for about a week.

Notes on the Activity

1. CAUTION: Since harmful organisms may be present, students *must not* open Petri dishes on which bacteria are growing.

2. The purpose of this activity is to demonstrate that bacteria are found all around us.

3. Demonstrate how to hold and open a Petri dish so students do not contaminate or break them.

4. Steps B through F suggest several ways of inoculating the dishes. Let the students use any alternative sources of inoculant that they can come up with.

5. An alternative procedure to Steps B through F is to have each plate divided into 4 quarters by drawing lines on the outside of the bottom of the dish with a marker, and numbering the quarters 1 to 4. On each of the quarters students can now check different samples for bacterial contamination.

6. For Step E touch a piece of tape, sticky side down, to the object being tested, and then lightly press the tape to the agar. A new piece of tape must be used for each surface tested.

7. Students should seal the dishes with cellophane tape and write their name, date, and the objects that were tested.

8. In Step H incubate all dishes upside down

in the dark for 1 or 2 days at 37° C, or 3 or 4 days in a warm room.

9. In Step I, along with the large, clearly visible colonies, there will also be many small microcolonies. You may count only the clearly visible colonies. Alternatively, use a colony counter, which is an illuminated box with a magnifier, and count the microcolonies also. Mold colonies will have a threadlike appearance.

10. Autoclave or soak all discarded glass Petri dishes, including the controls, in Lysol solution before cleaning them out. Plastic Petri dishes should be disposed of in a safe manner.

ANSWERS TO QUESTIONS

1. Answers will vary. Colonies will differ in size, color, surface appearance, shape, form of margin.
2. Answers will vary.
3. Answers will vary.
4. Answers will vary.
5. If there are no colonies, then the bacteria and molds did not come from the food and agar themselves. If the colonies appear, either the agar was not sterile, or it gave rise to bacteria.
6. It killed them.
7. It didn't keep them out.
8. It kept out outside bacteria.
9. Boiling for an hour killed those originally in the soup. No more could get in.
10. It showed that germs didn't come from his soup. It didn't prove that other germs may not arise without parents. NOTE: Explain to the students that after Pasteur set up bottles E, F, and G he boiled them, and then observed them. Some of Pasteur's original flasks are still germ free today, 100 years later.
11. They came from the air, *or* they came from dust in the air.
12. All the bacteria were killed by boiling, and no more could get in through the sealed glass.
13. The bacteria in the soup were killed by boiling. Germs from outside settled in the bent tube.
14. It seems that germs came from parents, not from dirt or soup. But the experiments don't prove this conclusively.

15 GRASS OF THE SEA Pages (61) 189 - (64) 192

BEHAVIOR OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. recognize algae.
b. tell the importance of algae in nature.
c. prepare slides of algae.
d. draw and identify cellular structures in protococcus, spirogyra, and diatoms.

TEACHING TIPS

1. This chapter includes 3 separate activities. Any or all of them may be done.
2. The chapter may appropriately be taught along with "Action Biology," *Ecology*.
3. In discussing the material in the chapter, stress the importance of algae to other forms of life. Through photosynthesis, algae produce most of the oxygen in the air, and produce most of the food manufactured by green plants. Not only aquatic animals, but other animals such as ocean birds indirectly feed on algae.
4. In Section B note the occurrence of sexual reproduction in simple plants.

ACTIVITIES

Materials (per student or per pair of students)
microscope
microscope lamp
slides
cover slips
dissecting needle
forceps
lens paper
dropper bottle of Lugol's iodine solution
protococcus
living spirogyra
prepared slide of conjugating spirogyra
prepared diatom slide
diatomaceous earth

Preparation of Materials

1. Collect protococcus. See NOTES ON THE ACTIVITY.
2. Collect spirogyra from the surface of a pond. Living cultures and prepared slides of conjugating spirogyra can be purchased from a biological supply house.
3. Diatomaceous earth can be purchased cheaply from a tropical pet fish store. Obtain prepared diatom slides from a biological supply house.
4. Purchase prepared Lugol's iodine solution, or prepare it according to instructions given in *Teacher's Guide, The Invisible World*, Chapter 4.

NOTES ON THE ACTIVITIES

PROTOCOCCUS ACTIVITY

1. Collect protococcus by scraping it off tree bark or carefully removing a few pieces of

loose bark. Protococcus is one of the green algae that is commonly found in the form of green powdery patches growing on the shaded (north) side of trees, rocks, sides of buildings, and sides of clay flowerpots. Do not confuse it with grayish-green crust-like lichens or leafy mosses. A lichen consists of a fungus and an alga living together symbiotically. The lichens may also be collected and studied.

2. In Step A use a dissecting needle to scrape protococcus onto the slide. Add 1 or 2 drops of water and a cover slip. Examine under low power and high power. The nucleus is difficult to see in the small cells.

SPIROGYRA ACTIVITY

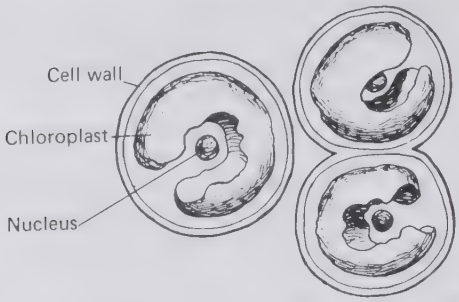
1. In Step A also add a cover slip and examine under low power.
2. In Step C the blue color of the starch test may take some time to develop in starchy areas (pyrenoids) of the spiral chloroplast because the iodine must first penetrate through the cell wall.
3. Review the iodine test for starch.

DIATOM ACTIVITY

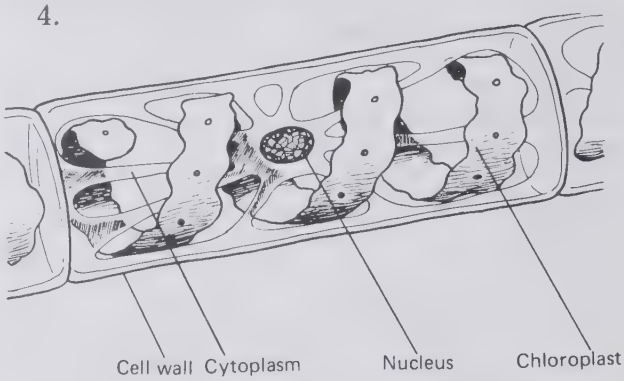
Mount a bit of diatomaceous earth in a drop of water on a slide. Add a cover slip and examine it microscopically, first using low power and then high power. Note the variety of shells, some broken, others entire. Prepared slides may also be used.

ANSWERS TO QUESTIONS

1.



2. The tree trunk is lightly damp, and protococcus has become used to this condition.
3. Cell wall, chloroplast, cytoplasm, cell membrane and nucleus.
4.



5. From its spiral chloroplast.
6. In parts of the chloroplast.
7. In mating or reproduction the male cell gives its protoplasm to the female cell.
8. Answers will vary. It is possible that students may have unique designs on their diatoms.
9. Water animals feed on algae just as land animals feed on grass, *or* water animals depend on algae for food just as land animals depend on grass.

SUPPLIES AND EQUIPMENT

Large Equipment

Incubator (optional)
Lamps, gooseneck or high intensity
Lamps, microscope
Microscopes, binocular dissecting
Microscopes, compound
Sterilizer (autoclave or pressure cooker)

Small Equipment

Beakers, assorted sizes
Bunsen burners
Corks
Cover slips
Cups, measuring
Dissecting needles
Dropper bottles
Droppers
Forceps
Knife
Lens paper
Loops, transfer
Magnifiers
Petri dishes
Razor blades, single-edged
Scissors
Slides, microscope
Spoons
Staining dishes
Test tube racks
Test tubes, small
Vials

Chemicals

Alcohol (cheapest)
Alcohol, ethyl
Calcium oxide
Congo red stain
Epsom salt
Glucose
Glycerin
Iodine, crystalline (optional)
Lugol's iodine solution
Methyl cellulose
Methyl red indicator
Methylene blue stain
Methylene blue thiocyanate tablets (optional)
Nutrient agar
Potassium iodide (optional)

Safranine stain
Sodium chloride
Starch
Sugar, granulated
Tartaric acid

Biological Materials

Ameba (live)
Brine shrimp eggs
Elodea (live)
Euglena (live)
Frogs (live)
Microfossils (diatomaceous earth)
Paramecium (live)
Protococcus (collect it)
Protozoa (live), mixed
Spirogyra (live)

Prepared Slides

Cartilage (optional)
Diatoms (optional)
Epithelium tissue (optional)
Hydra, cross section (optional)
Intestine, cross section (optional)
Liver (optional)
Protozoa (optional)
Spirogyra, conjugating

Consumables Obtainable Locally

Baby food jars with lids
Beans, dry
Beef, ground
Bread
Cabbage
Cans, empty
Cotton fibers
Cotton, nonabsorbent
Jars
Labels
Lysol disinfectant (bottle)
Markers, glass
Milk
Milk, powdered
Mineral oil
Newspaper
Nylon brush
Onion
Paper cups, small
Paper towels
Plastic sandwich bags
Q-Tips
Sauerkraut
Soap
Spoons, plastic
Stamp pad (optional)
Sugar, brown
Synthetic fibers
Talcum powder
Tape, cellophane
Toothpaste
Toothpicks, flat
Vaseline
Wool
Yeast, package or cake
Yogurt, plain

AUDIOVISUAL MATERIALS

For meaning of abbreviations, see *Teacher's Guide,* page 131.

Ameba. Film Loop Series, EBE.

Ameba Proteus. Film Loop, Ealing.

Amoeba. B&W, 11 min., Univ. (Structure and functions.)

An Inquiry—The Importance of the Nucleus. Film Loop, BSCS.

And the Earth Shall Give Back Life. B&W, 25 min., Free Loan, Squibb. (Antibiotics as drugs.)

Antibiotic Production by a Mold. Film Loop, EBE.

Antibiotic Sensitivity Testing. Film Loop, EBE.

Antibiotics. B&W, 14 min., EBE. (Describes Fleming's work. Shows use of antibiotics in medicine and for other purposes.)

Bacteria. Color or B&W, 19 min., EBE. (Basic characteristics and ecology.)

Bacteria—Friend or Foe. Color or B&W, 11 min., EBE.

Bacteria: Laboratory Study. Color or B&W, 15 min., Indiana Univ. (Shows laboratory procedures; contrasts bacteria with other microorganisms.)

A Bacterial Growth Curve. Film Loop, EBE.

Budding Yeast. Film Loop, Ealing.

A Career in Bacteriology. Color or B&W, 15 min., Indiana Univ. (Contributions of bacteriology; opportunities and rewards in the field.)

The Cell. B&W, 15 min., Upjohn Co.; Sterling Movies, U.S.A. (Modern concepts of cell structure.)

Cell Biology: Structure and Composition. Color or B&W, 14 min., Coronet.

The Cell Principle and Biogenesis. Color, 16 min., MGH.

The Cell: Structural Unit of Life. Color or B&W, 10 min., Coronet. (Presents cell structure, comparisons among cells, and cell specialization.)

Cells and Their Function. B&W, 14 min., Contemporary Films. (Growth and behavior of cells and tissues studied through technique of tissue culture.)

Common Bacterial Types. Film Loop, EBE.

The Compound Microscope. Color, 20 min., Bausch and Lomb. (Parts of the microscope, optics, and technique in using the microscope.)

Cytoplasmic Streaming in Plant Cells. Film Loop, BFA.

Dental Health— How and Why. Color or B&W, 11 min., Coronet. (Diet and its relation to the growth and decay of teeth.)

Electron Microscopy. Color, 23 min., International Film Bureau.

First Major Test of Penicillin. B&W, 25 min., MGH. (Shows experimentation in Fleming's

own laboratory, and the use and production of penicillin.)

Fresh Water Plankton and the Chain of Life. Color, 16 min., Fleetwood Films. (Shows blue-green, green, and golden algae.)

From One Cell. Color, 14 min., American Cancer Society.

Fungi. Color or B&W, 16 min., EBE. (Physiology and economic importance.)

Health Heroes: The Battle Against Disease. B&W, 11 min., Coronet. (Discusses van Leeuwenhoek, Jenner, Koch, Pasteur, and Lister.)

How Protozoa Move. Film Loop, EBE.

Infectious Diseases and Man-Made Defenses. Color or B&W, 11 min., Coronet. (Antibodies, vaccines, and antibiotics.)

Life of the Molds. Color, 20 min., Chas. Pfizer and Sterling Movies, U.S.A. (Characteristics, life cycles, and importance of molds.)

Life Story of Paramecium. Color or B&W, 11 min., EBE.

Man Against Microbes. B&W, 11 min., Free Loan. Metropolitan Life Insurance Co. (The work of Leeuwenhoek, Pasteur, Koch, Lister, and von Behring.)

Microorganisms That Cause Disease. Color or B&W, 11 min., Coronet. (Five types of microbes and their effects on cells.)

Microorganisms: Beneficial Activities. Color or B&W, 15 min., Indiana Univ. (Stresses ecological and economic importance of bacteria.)

The Microscope. Color or B&W, 11 min., MGH. (Emphasizes use of the microscope.)

Microscope and Its Use. B&W, 10 min., MGH.

Microscope Techniques: Use a Microscope. Film Loop, BFA.

Microscopic Fungi. Color, 17 min., National Film Board of Canada and MGH. (Survey of this group of microorganisms.)

Microscopy Techniques. Film Loop, Ealing.

Molds Under the Microscope. Film Loop, EBE.

Origin of Life. Film Loop Series, Ealing.

Origin of Living Things. Filmstrip, Popular Science.

The Paramecium. Film Loop, EBE.

Paramecium Aurelia. Film Loop, Ealing.

The Protist Kingdom. Color, 14 min., Film Associates of California. (Good introductory, slow-paced film.)

Protists. Film Loop, BFA.

Protozoa—One Celled Animals. Color or B&W, 11 min., EBE.

Protozoa: Structures and Life Functions. Color or B&W, 17 min., Coronet. (Uses interference microscopy and other means to show the four classes of protozoa.)

The Single-Celled Animals: Protozoa. Color or B&W, 17 min., EBE. (Characteristics, behavior, and ecology of the group.)

Spontaneous Generation—Part I: Controlled Observations. Film Loop, EBE.

Spontaneous Generation—Part II: Effect of Microorganisms in Air. Film Loop, EBE.

Story of Dr. Jenner. B&W, 10 min., Teaching Film Custodians. (Dramatic presentation of the development of vaccination.)

The Story of Dr. Lister. Color, 29 min., Warner-Lambert Pharmaceutical Co. and Modern Learning Aids. (Interesting account of Lister's work on antiseptic surgery.)

The Story of Louis Pasteur (Anthrax Sequence). B&W, 17 min., Teaching Film Custodians. (Extract from commercial film illustrating the origin of the germ theory of disease.)

The Story of Louis Pasteur (Hydrophobia Sequence). See above. (Illustrates Pasteur's work in developing artificial immunity.)

The Teeth—Development and Care. B&W, 11 min., EBE. (Development of teeth, diet and teeth, brushing and how dentist cares for teeth.)

Teeth—Their Structure and Care. B&W, 11 min., Coronet. (Function, structure, and decay of teeth.)

What Is a Cell? Color or B&W, 28 min., AIBS Series, MGH. (Stresses techniques of cell research.)

Where Bacteria Are Found. Film Loop, EBE.

World of Little Things. Color, 14 min., Moody. (Shows various protozoa; also algae and diatoms.)

Your Teeth. Color, 6 min., EBE. (Decay and good dental health.)

ECOLOGY

CONTENTS

PLAN AHEAD for the following lessons:

Chapter		
	1	Collect baby food jars and set up micro-zoo cultures.
	2	Obtain rich soil samples and set up funnel trap for roundworms.
	3	Obtain living and preserved earthworms.
	4	Obtain bowls, eggbeater, electric mixer, or blender. Soak pieces of newspaper in advance of activity.
	5	Obtain scraps of wood from a lumberyard. Collect classified ad sections. Prepare tree puzzles.
	6	Assemble materials for Chlorophyll Activity. Obtain variegated coleus plant.
	7	Germinate grass seedlings 7 to 10 days before activity. Obtain cobalt chloride paper.
	8	Prepare phenol red indicator. Obtain elodea.
	9	Prepare decks of cards for ECOLOGY RUMMY.
	10	Obtain a road map of your local area. Duplicate copies of the ENVIRONMENT WORKSHEET.
	12	Prepare simulated lake water a day or 2 in advance, and simulated sewage 1 week in advance. Duplicate copies of the WATER POLLUTION WORKSHEET.
	13	Prepare Smog Detector and smog test solution.

14 Collect a good supply of classroom litter. Spike the room on the day of the activity.
15 Obtain graph paper and rulers.

1 LIFE IN A DROP OF WATER Pages (3) 195 - (6) 198

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. state the characteristics of algae, fungi, and protozoa.
b. define ecology.
c. state the function of decayers.
d. list some of the living organisms found in a drop of water.
e. set up a "micro-zoo" and investigate the presence of microscopic life in the water.

TEACHING TIPS

1. Begin this introductory chapter to ecology by asking students to name the organisms in a fishtank. Discuss the relationships among the organisms.
2. In Section E emphasize that ecology is the study of relations between living things and their surroundings. Challenge students to give examples of a living thing that is not connected to another living thing. Use the board to trace the connections of the examples to other living things.

DROP-OF-WATER ACTIVITY

Materials (per pair of students)
- baby food jar of fishtank water with some debris
- jars of water from a variety of sources
- droppers
- slide and cover slip
- microscope
- lens paper
- paper towels
- baby food jars with lids and materials for micro-zoos
- marker or labels
- charts of protozoa, algae, and other microorganisms (optional)

Preparation of Materials
To ensure having adequate samples for observation, set up some cultures on your own a week before the activity.

Notes on the Activity
1. Cultures of pond water or mixed protozoa can be purchased from biological supply houses.
2. To review or teach the use of the microscope and the preparation of a wet mount, see "Action Biology," *The Invisible World,* Chapters 1 and 2.
3. Protists are most abundant in samples of water which contain cloudy areas, scum, or debris.
4. Use a kitchen baster or long pipette to obtain samples of fishtank water with debris in it. Dispense the samples in baby food jars.
5. Baby food jars make excellent culture dishes. They must be thoroughly rinsed of all traces of soap or detergent, and several holes should be punched in their covers.
6. Interest in this activity is greatly heightened if students examine their own samples of water. About a week before the activity, have students set up their own "micro-zoo" in baby food jars. If the materials listed in Step D are not available, set up infusions with damp, rich black dirt, decaying leaves, straw, or dry grass. Use pond water, bottled water, or aged tap water (left standing 24 hours) in the micro-zoos. Do *not* use fresh tap water; the chlorine in it will kill microorganisms. Keep the zoos in a well-lighted area, but not in direct sunlight.
7. To demonstrate succession in an aquatic micro-community, observe the micro-zoos over a period of several weeks.
8. Samples for examination should be taken from the bottom, middle, and top of each culture jar. Assist students in making wet mounts. Slides should be examined under low power with reduced light. Survey the whole slide for microorganisms, especially along the edges of the cover slip.
9. Sometimes several slides must be prepared before a microorganism can be located. Encourage students to try and try again.
10. Remind students to dry the slide and cover slip before making each wet mount.
11. Various non-moving objects on the slide may be air bubbles, dead organisms, or debris.
12. Students should make sketches of all organisms they observe.
13. Use a microprojector to let students show the class the organisms in their micro-zoos.
14. EXTRA. Scrape some algae off the glass wall of a fishtank and have students prepare a wet mount and observe under low power.

ANSWERS TO QUESTIONS

1. Algae are simple plants that contain chlorophyll.
2. If fungi did not decay or break down dead organisms, the world would be cluttered with them.
3. Fungi are simple plants which never contain chlorophyll.
4. Ecology is the study of the relationship of living organisms to one another and their environment.
5. Answers will vary.

2 THE WORLD IN THE SOIL Pages (7) 199 - (10) 202

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. contrast sand with dirt.
b. define and give examples of producers, consumers, and decomposers.
c. define and give examples of a community.
d. describe some of the microscopic organisms found in rich soil.
e. identify soil roundworms.

TEACHING TIPS

1. Emphasize that all communities contain producers, consumers, and decomposers.
2. Contrast the characteristics of "dead" sand and "living" soil.
3. Nematodes, or roundworms occur everywhere in fantastic numbers. It has been said that if all matter were removed from the earth except nematodes, the outlines of mountains, valleys, cities, plants, and animals would still be dimly recognizable. Hookworm and trichina (pork) are roundworms that cause disease in man.

SOIL ANIMAL ACTIVITY

Materials (per pair of students)
microscope
slide
cover slip
sand
rich, damp soil
plastic spoons
paper towel
dropper bottle of methylene blue stain

(per group of 6)
worm trap funnel—glass funnel, rubber tubing, pinch clamp, paper towelling, rich humus soil
jar or ring stand to support funnel
dish (half a Petri dish)
brilliant green dry stain
small chemical spoon or flat toothpick

Preparation of Materials

1. Collect nematodes 1 or 2 days in advance of the activity by setting up funnels as shown in Step D. Wrap a handful of moist, humus-rich soil in some paper towelling, gauze, or cheesecloth and place it in the funnel. Fill the funnel with water just above the level of the soil. Open the pinch clamp enough to fill the spout and rubber tube with water. Support the funnel in a jar or on a ring stand, and wait 1 or 2 days.
2. For the preparation of methylene blue, see *Teacher's Guide, The Invisible World,* Chapter 4.

Notes on the Activity

1. To review or teach the use of the microscope and the preparation of a wet mount, see "Action Biology," *The Invisible World,* Chapters 1 and 2.
2. In Step A use damp soil that is rich in humus. Keep the soil damp.
3. In Step B add 1 or 2 drops of methylene blue and place a cover slip on the slides. The stain will accumulate in living cells or become bound to material of biological origin. It will also increase the color contrast of objects that absorb them.
4. In Step C examine the slide under low power, then high power. Assist students in finding microorganisms such as yeasts (colorless spheroids), bacteria (very small rods, spheres, or spirals), algae (single or multicellular organisms with green chloroplasts), blue-green algae (filamentous or spherical organisms), fungi (filamentous), protozoa (motile cells), small crustaceans (jointed appendages), or worms.
5. EXTRA. For Steps A to C make a wet mount of soil. Observe it with and without stain. Contrast the 2 preparations in words or drawings.
6. In Step E stress that only a few drops of water should be run into the dish.
7. Use a microscope for Steps F, G, and H; examine under low power while carefully adjusting the light.
8. For Step F make a wet mount of the water obtained from the worm trap in Step E.

Note the characteristic whip-like movement of the roundworms.

9. For Step G add a drop of methylene blue stain to the slide by drawing it under the cover slip with paper towelling.

10. In Step H add a few grains of brilliant green stain to a drop of liquid culture from the worm trap. Add a cover slip and examine under low power. The stain is green at pH 4 or 5, blue or colorless above pH 5, pink, orange, or yellow below pH 4. Color differences in the digestive tract should be apparent. They indicate that the digestive tube is differentiated, with pH differences in various stages of digestion.

ANSWERS TO QUESTIONS

1. Sand is lifeless and consists of small rock-like particles. Soil contains living organisms and particles of varying size.
2. Answers will vary.
3. They move in a whip-like manner.
4. The brilliant green stain changed colors in different parts of the digestive tube.
5. Answers will vary.
6. Producer plants make food. Animals are consumers and eat food. Decomposers break down dead plants and animals.
7. All the living things—producers, consumers, and decomposers—living together in 1 place.

3 NIGHT CRAWLERS Pages (11) 203 - (14) 206

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe how tapeworms are harmful.
b. define parasite and give an example.
c. describe the external anatomy of a segmented worm; an earthworm.
d. tell why earthworms are called "nature's plows."
e. give examples of segmented worms.
f. determine the pulse rate of an earthworm.
g. test the reaction of a living earthworm to various stimuli.
h. properly dissect an earthworm.
i. identify, with assistance, the organs and structures of an earthworm.

TEACHING TIPS

1. In Section A develop the concept of parasitism. Give additional examples.
2. In Section C stress the important role earthworms play in soil ecology. After the activity, discuss how this animal is adapted in structure and function to its life in the soil.
3. If you wish, contrast roundworms, flatworms, and segmented worms.

EARTHWORM ACTIVITY

Materials (per pair of students)

live earthworms
preserved earthworms
dissecting pan
hand lens (optional)
paper towels
scissors
forceps
dissecting needle
straight pins
large test tube

(per group of 6 to 8)

weak acid (vinegar)
Q-Tips
flashlight
jar of ice chips
jar of warm water
watch with second hand
pan of loose soil
binocular dissecting microscope (optional)

(per class)

earthworm chart and model

Notes on the Activity

1. Obtain preserved earthworms from a biological supply house. Live earthworms may be purchased from a fish bait store or biological supply house, or may be collected by digging in moist soil. Maintain live earthworms in moist soil (do not overwet) with humus, peat moss, or dried leaves. Keep in a dark and cool place 16°–18° C (60°–65° F).
2. It is very important for students to keep their earthworms moist. If the worm dries out, it will die. Periodically during the activity, cover the earthworm with damp paper towelling for a few minutes. Observe how the earthworm responds to this.
3. If living earthworms are not available, omit Steps D, E, and F.
4. Use a hand lens in Steps B, C, and F.
5. The "belt" referred to in Step A is the clitellum, or thickened band.
6. In Step B the anterior end is more pointed and has a prostomium ("lip") projecting over the mouth.
7. In Step C there are 4 pairs of bristles on each segment. They point backward.
8. In Step D the dorsal blood vessel can be seen through the skin.
9. For Step E dampen a Q-Tip in vinegar or another weak acid and bring the applicator

close to the various parts of the worm's body. Observe and record the animal's response. It will rapidly squirm away.
Note: *Do not touch the worm with the acid.* If this happens, rinse worm in water.

Test the worm with a chip of ice. While all parts of the body are sensitive, the region around the mouth is likely to be most responsive.

To find out how the earthworm reacts to light, cover the lens of a flashlight, leaving a small opening. Use the resulting narrow beam to determine that all parts of the worm's body are sensitive to light.

Place the worm on a pan of loose soil and expose it to light. The worm will burrow into the soil very quickly, front end first.

Gently touch various parts of the earthworm and note the squirming response.

Place a beaker or jar of very warm water near the worm. The worm will move away.

10. Internal organs are best seen in preserved specimens. If you dissect living earthworms, anesthetize them by placing drops of 70% ethyl alcohol on the worms until they relax.

11. Simple synonyms are used for scientific terms, as follows:

Scientific term	*Synonym*
clitellum	belt
pharynx	throat
esophagus	gullet
crop	soft stomach
seminal vesicles	sex glands
aortic arch	heart

12. Demonstrate how to dissect the earthworm. Assist students with their dissections by asking them to identify various structures. Have available in the room charts, models, or transparencies of the earthworm.

13. For Step H tell the students that the names of the parts of the digestive tube are listed in order. Starting from the front end the parts are the throat (pharynx), gullet (esophagus), soft stomach (crop), hard gizzard, and long intestine. With a little assistance, students should be able to identify all these parts.

ANSWERS TO QUESTIONS

1. Tapeworms are parasites. Much of the food eaten by the victim is absorbed by the tapeworm.
2. It plows the ground by burrowing, so air and water can soak in easily.
3. It fertilizes the soil with its waste matter.
4. There are about 120 segments. They are not all the same size; those in front of the belt are larger.
5. The front end is more pointed than the tail end. The belt is near the front end. The front end has a "lip" (prostomium) over the mouth opening.
6. The bristles anchor the front end of the worm while the back end contracts and moves forward. Then the back end is anchored by the bristles while the front end pushes forward.
7. The blood moves forward in the blood vessel.
8. The pulse rate at room temperature is about 30 per minute.
9. Answers will vary. Earthworm is sensitive to light, cold, acid, touch, and warmth.
10. It extends and contracts its body.
11. The segments are separated by walls (septa).
12. There are 5 pairs of hearts. They connect the back blood vessel with the front blood vessel.
13. The sex glands are whitish, saclike structures along the esophagus.
14. The brain is connected to a nerve cord that runs down the front (belly) of the worm.

4 THE FOREST IN THE CITY Pages (15) 207 - (18) 210

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. name and describe some of the plants that grow in an urban environment.
b. distinguish between an herb and a tree.
c. describe a typical flowering plant.
d. describe the benefits of recycling paper.
e. demonstrate how to recycle paper.

TEACHING TIPS

1. Chapter 4 discusses the variety of plants found in an urban setting. Take the class on a field trip to identify the plants found in the vicinity of the school. Observe plants growing in vacant lots, in cracks on the sidewalk, in a park, on the school grounds, between buildings, etc.
2. Illustrate Section A with sample mosses and ferns.
3. In Sections C, D, and E distinguish

between herbs, shrubs, and trees. Show examples of each.

4. Discuss the economic importance of plants. Elicit and list on the chalkboard the names and uses of plants and plant products.

5. Introduce Section F with a discussion of how the human race would be affected if there was a shortage of trees.

PAPER-RECYCLING ACTIVITY

Materials (per group of 4 or 5)
- old newspaper
- eggbeater, electric mixer, or blender
- bowl
- wallpaper paste (or instant laundry starch)
- block of wood or book
- jar or beaker
- spoon
- plastic wrap
- soaking paper scraps

(per student)
- 8-cm square of window screening

Preparation of Materials

1. Excellent bowls can be made from the bottom half of plastic bleach bottles, milk cartons or other containers.
2. Obtain screening from a hardware store. Size of screening or block of wood is not critical.
3. Soak paper pieces overnight.

Notes on the Activity

1. In Step A half a sheet of newspaper torn into small pieces should be sufficient for each group. Paper pieces must soak for at least 1 hour. Alternatively, soak enough paper overnight for the whole class and portion it out on the day of the activity.
2. In Step B beat the paper pieces and water with an eggbeater or electric mixer until the paper falls apart into fibers and the mixture has a creamy appearance. Since spattering will occur, spread newspapers around the area so cleaning up will be easy.
3. In Step C use wallpaper paste or powdered instant laundry starch.
4. In Step D hold the window screening horizontally and dip it into the mixture. Stir the mixture and repeat the dipping process until the screen is covered with an even layer about 2 mm thick.
5. Every student in the class should make a screen of recycled paper.
6. For Step E cut plastic wrap into small squares slightly larger than screening.
7. In Step E place window screen with paper fibers upward on several sheets of newspaper. Cover with plastic wrap and use any flat hard object such as a block of wood or book to squeeze out the water.
8. In Step F, to speed up drying, place the screen in a medium hot (350° F) oven or incubator. A hair dryer can also be used. A knife or scalpel is helpful in removing the *dry* recycled paper from the screen.
9. *Alternatively, the Paper-Recycling Activity can be completed in 1 period by using a blender.* Blend paper pieces and 750 ml of water for about 1 minute. Then blend in a heaping tablespoon of instant laundry starch or wallpaper paste. Dip screens and dry them in an oven. While the screens are drying, go over the chapter.

Leave time at the end of the period for peeling the recycled paper off the screens.

ANSWERS TO QUESTIONS

1. Answers will vary.
2. Answers will vary.
3. Answers will vary. The following plants are herbs: milkweed, dandelion, grass, clover, tomato, cucumber, celery, carrot, radish, squash, strawberry, stringbean, spinach, gladiolus, tulip, African violet.
4. If we recycle paper, we will need to cut down fewer trees. Also, there will be less air pollution and garbage if paper is recycled instead of burned or buried.

5 SOFTWOOD, HARDWOOD Pages (19) 211 - (22) 214

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. distinguish between softwood and hardwood.
b. characterize an evergreen.
c. describe a cross section of a typical tree trunk.
d. explain the function of cambium.
e. distinguish between sapwood and heartwood.
f. count and interpret tree rings.
g. list jobs connected with the wood or paper industry.

TEACHING TIPS

1. **Materials**
   - scraps of softwood
   - scraps of hardwood

nails
hammers
evergreen branch with needles attached (optional)
broadleaf branch with leaves attached (optional)
cross section of tree trunk (optional)
longitudinal sections of tree trunk (optional)
classified ad sections (one for each student)

2. You may want to begin the lesson by challenging students to drive nails into scraps of hardwood and softwood. Wood scraps can be obtained from most lumberyards.
3. Take a field trip to identify trees in the vicinity of the school.
4. Display leaf and wood samples when discussing evergreens, softwoods, and hardwoods.
5. Tree shape is generally characteristic of species. Have students describe the general shape of the 3 trees shown on the bottom of page (19) 211.
6. For Sections C, D, E, and F display varnished or shellacked cross and longitudinal sections of tree trunks.
7. The cambium is a difficult concept for many students to understand. Use a visual aid or demonstration slide to illustrate this concept.
8. Using the drawings of a tree trunk on page (20) 212, ask students to contrast a cross section with a lengthwise section. Also ask students to characterize type of section and wood of the various wood samples in the room (e.g., desks, cabinets, flooring, or moldings).
9. For Section F have students count the tree rings in actual samples.
10. For Section G have students discuss their experiences in carpentry. Have a carpenter, cabinetmaker, or lumberyard man talk to your class about working with wood. For question 8 provide each student with a copy of the classified ad section of your local newspaper. If time is available, have students write a brief description of the jobs they find in the classified ads.

TREE PUZZLE ACTIVITY

Materials (per group of 4)
tree puzzle
magnifying glass (optional)
small hand saw (keyhole or coping)
intact tree branches
clock
visual aid of external anatomy of a twig (optional)

Preparation of Materials
1. Tree puzzles are made by sawing leafless, large 1 to 2 meter branches into 8-cm sections. If tree limbs are not readily available, make puzzles out of finished pieces of well grained lumber. Lumberyards can cut the wood into 8-cm sections.
2. For best results wood should be dry before you saw it, and cuts should be made at right angles. An electric band saw will give the smoothest cuts. A cooperative shop teacher or custodian can do the job quickly.
3. The early spring or late fall is a good time to collect branches. Branches can be obtained, often just for the asking, from professional tree pruners, electric power company tree pruners, municipal tree pruners, and home owners.
4. If you cut branches yourself from a tree, make a clean cut with a saw, and seal cuts 2 cm or more in diameter with tar or paint.
5. Store tree puzzles in large paper bags.

Notes on the Activity
1. The purpose of this activity is to motivate the examination of the external and internal structures of a tree's stem. To put the pieces of the tree puzzle together students must use both bark and ring patterns as clues.
2. Make available visual aids which show the external anatomy of a twig.
3. Assist students having difficulty putting their tree puzzles together.
4. In Step C students enjoy making mini-tree puzzles from twigs and exchanging them.

ANSWERS TO QUESTIONS

1. Softwood.
2. They look pretty and smell nice.
3. Answers will vary.
4. As the cambium divides, it makes new cells for the trunk. The cells on the inside of the cambium grow into new wood cells.
5. Yes.
6. The house was built in 1894. You can tell how old beam B is by matching its ring pattern with the other beam and counting rings.
7. The 1959 ring is very wide.
8. Answers will vary.

6 ALL FOOD IS GREEN Pages (23) 215 - (26) 218

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. explain the meaning of the chapter title.
b. prepare an extract of spinach leaves.

c. separate pigments by paper chromatography.
d. count the number of pigment spots separated by chromatography.
e. locate starch in a variegated leaf.
f. discuss the significance of chlorophyll in photosynthesis.
g. summarize the process of photosynthesis.
h. identify some of the factors that affect the price of meat.

TEACHING TIPS

1. Along with Chapter 8, this chapter develops the concept of photosynthesis.
2. In class discussion stress the ecological importance of green plants as producers of food. Challenge students to name a food that does not have a plant origin, or an organism that does not get its food ultimately from a plant source.
3. Section B and question 7 emphasize the factors that affect the price of milk and meat products. Ask class to list other factors that affect food prices.
4. Summarize Section B with the word and formula equation for photosynthesis:

carbon dioxide + water $\xrightarrow{\text{sunlight, chlorophyll}}$ glucose + oxygen

$$CO_2 \quad H_2O \longrightarrow C_6H_{12}O_6 \quad O_2$$

5. For the activity, discuss in simple terms the theoretical basis for paper chromatography. As the liquid solvent moves up the paper, it carries the various substances at different rates. The rate at which a substance moves is dependent on size of molecule, tendency to adhere to paper, and ability to dissolve in the solvent. Part II demonstrates the pigments or dyes found in a leaf. Part III demonstrates that starch is found only in the part of the leaf containing green chlorophyll.

CHLOROPHYLL ACTIVITY

Materials (per pair of students)
2 filter paper strips
ruler and pencil
2 toothpicks or capillary tubes
2 stoppered (cork or rubber) test tubes
test tube rack
mortar and pestle
tape or thumb tacks
forceps (tweezers)
Petri or other shallow dish
paper towels

(per group of 6)
beaker of water
flask of acetone
2 droppers
spinach leaves (fresh or frozen)
flask of developer (petroleum ether mixture)
black ink or mixture of food coloring
dropper bottle of iodine solution

(per class)
2 or 3 variegated coleus plants
lamp
2 hot plates
2 long forceps or tongs
beaker of hot water
alcohol-hot water bath
95% ethanol or rubbing isopropyl alcohol

Preparation of Materials
1. Using a paper cutter, cut filter paper strips to fit stoppered test tubes without touching sides.
2. Washable black ink, such as Skrip, will usually produce a good chromatogram. Check your ink in advance of the activity. A mixture of different food coloring dyes can also be used.
3. Use any of the following developers:
a. Mix 92 parts petroleum ether with 8 parts acetone.
b. Mix 2 parts petroleum ether with 1 part benzene.
c. Mix 8 parts petroleum ether with 1 part acetone and 1 part benzene.
d. Petroleum ether alone.
Note: Petroleum ether is not an anesthetic.
4. To prepare iodine solution dissolve 6 g potassium iodide (KI) in 100 ml of water. Then dissolve 4 g iodine (I_2). Or, use Lugol's iodine solution. Directions for preparation are found in *Teacher's Guide, The Invisible World,* Chapter 4. Store and dispense in brown or aluminum-covered bottles.
5. Obtain plants from local greenhouse or florist. If coleus or silver leaf geranium plants are not available, use other green plants but clip small light shields of aluminum foil or black paper to the leaves. For best results, the plants used in Part III should be kept under bright light (lamps not too close) for several hours before the activity.
6. Use cheapest alcohol for Step K.

Notes on the Activity
1. CAUTION: Substances used in this exercise are volatile and flammable. *There must be no flame in the room at any time during the activity. Room must be well ventilated. Do not inhale fumes.*
2. If equipment or space is limited, all 3 parts of the activity can be done simultaneously by different groups.
3. For Steps A and F remind students to draw a pencil line about 2 cm from the bottom of paper and to place spots in the middle of the line.
4. In Steps B and G fasten the filter paper strip to the stopper by using tape, a thumb tack, or a pin bent in the shape of a hook. Some teachers don't attach the paper to the stopper.
5. In Step E several pairs of students can

share the same extract. Stress that only 2 or 3 leaves and several drops of acetone should be used. Add additional drops of acetone as needed. To ensure good results, the extract must be a dark green color. Many teachers prepare an extract in advance. If a blender is available, use it to grind spinach leaves in acetone and filter the extract. If thawed frozen spinach is used, press out excess water on paper towelling before grinding.

6. For Steps C, D, G, and H, place test tubes in a test tube rack. Caution students not to move or shake them while the chromatograms are developing.

7. In Step F assist students in making tiny dark green spots. The spotting and drying operations must be repeated several times. Hasten drying by blowing or waving paper in the air.

8. In Steps D and H warn students to remove the filter strips from the tubes before any pigments migrate to the top of the paper. The pigments can be identified by their color: chlorophyll B (bottom band), pale green; chlorophyll A, blue green; xanthophyll, pale yellow; and carotene (top band), deep yellow.

9. In Step K, *if alcohol in beaker catches fire, carefully smother with a wet cloth or wet paper towels.*

10. For Step L review or teach the iodine test for starch.

ANSWERS TO QUESTIONS

1. Four dyes.
2. The green part of the leaf.
3. Directly or indirectly, green plants provide the food for all animals.
4. Sugar (changed to starch by cells).
5. Water and carbon dioxide.
6. It can capture energy from light and use it in photosynthesis.
7. Answers will vary. Generally, the theory of supply and demand.

7 THE WATER ELEVATOR Pages (27) 219 - (32) 224

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe the water cycle.
b. state the meaning of the chapter title.
c. describe the 3 forces involved when water travels up a plant.
d. define transpiration.
e. describe the effect of plants on the water cycle.
f. describe the effect of people on the water cycle.
g. examine the roots of grass seedlings under the microscope.
h. observe growing root hairs.
i. demonstrate that water rises in the stem.
j. use cobalt paper to detect transpiration and to show which side of a leaf contains more stomates.
k. prepare a wet mount of leaf epidermis.
l. observe stomates in a leaf.
m. demonstrate the effect of salt water on guard cells.
n. state how guard cells control transpiration.

TEACHING TIPS

1. Begin the chapter by discussing the source of fresh water in your locality. Challenge students to name a living thing that does not need water. Water pollution will be covered in "Action Biology," *Ecology,* Chapter 12.

2. In teaching Section A, go over the simplified water cycle diagram. In Section B, use the photograph of a field of squash plant leaves to explain the meaning of the word wilt.

3. The title of this chapter refers to water relations in plants. Sections B, C, and D discuss how water travels up a plant. Ask students to hypothesize how water travels to the uppermost leaves of a tall tree. Then go over the 3 forces involved in the process.

4. In teaching Section C, use visual aids of stems and roots to demonstrate the cells involved in water transport. Ask students how root hairs, depicted in the diagram on page (29) 221, are adapted to absorb water from soil.

5. In teaching Section D, use a model chart or transparency of a leaf. Stress the importance of transpiration.

6. In Section E stress the importance of the water cycle in providing living things with a continuous supply of fresh water, and discuss how man is tampering with it.

WATER ELEVATOR ACTIVITY

Materials (per group of 4 or 6)
Part I
creeping bent grass seedlings, 1 week old
single-edged razor blade
dropper bottle of balanced salt solution (Step A) or plain water

forceps
slide
cover slip
toothpick or fine artist brush
microscope
microscope lamp
lens paper
Vaseline or omniwax

Part II
celery stalk
sharp scalpel or single-edged razor blade
beaker or jar
red food coloring or red washable ink
light source
ruler
clock
water

Part III
2 cobalt chloride paper strips
forceps
2 glass slides
tape
2 paper clips (optional)

Part IV
lettuce or other leaf
forceps
dissecting needle
slide
cover slip
dropper bottle of water
dropper bottle of 5% salt solution (Step Q)
paper towelling
microscope
microscope lamp
lens paper

(per class)
large container of water
2 or 3 geranium plants

Preparation of Materials

1. Part I: Creeping bent seeds may be obtained from a seed or hardware store and germinated on wet paper towelling or wet filter paper in covered Petri dishes. Store in dark. The seeds sprout within 3 days and are ready in a week. To prepare the roots for observation, mount them in a balanced salt solution of:

NaCl	1.30 g
KCl	0.30 g
$CaCl_2$	0.04 g
$NaHCO_3$	0.02 g
Phosphate buffer (purchased) with pH of 6.9–7.0	50 ml
Distilled water to 1 liter	

For use, dilute the stock solution 9:1. *Water may be used in place of the balanced salt solution.* Other grass seed, like red top, may be substituted. An alternative way to germinate grass seeds is to sprinkle them on the surface of a bowl of water. In 7 to 10 days the floating germinated grass seeds are ready for use.

Radish seeds may also be examined. Germinate 6 to 10 seeds 4 to 6 days before the activity on wet paper towelling in closed Petri dishes. Examine closed dishes under a binocular dissecting microscope. If living material is not available, students can study prepared slides of a longitudinal section through an onion root tip and a root cross section.

2. Part II: For best results use only fresh celery stalks with leaves on them. Place celery in cold fresh water at least 1 hour before the activity.

3. Part III: Buy cobalt chloride paper from a biological supply house, or make it in the laboratory. Make cobalt chloride paper by soaking filter paper in a 3% to 5% aqueous solution of cobalt chloride. Dry in a warm oven and cut into small strips. Store strips in airtight bottles. Place a small amount of desiccant, such as silica gel or anhydrous calcium chloride, in the bottom of each bottle under a layer of cotton. If the cobalt chloride paper turns pink before use, heat in oven or over a flame until the paper turns blue.

4. Part IV: Lettuce leaves should be kept in a dish of distilled water. To prepare a 5% salt solution, dissolve 5 g sodium chloride in 100 ml of water.

Notes on the Activity

1. Each group of students should perform all 4 parts of the activity.

2. The microscope activities in "Action Biology," *The Invisible World,* Chapters 1 and 2, are necessary preparation for Parts I and IV of this activity. Also demonstrate the preparation and sealing of a wet mount.

3. Part I: Use forceps to carefully pick up grass seedlings and transfer them to slide.

4. In Step A assist students in distinguishing between young shoot and root.

5. In Step B emphasize that *slight* pressure on cover slip will flatten the root.

6. In Step C seal slide with Vaseline or omniwax.

7. In Steps D and E cell growth and differentiation will be observed. Root hairs grow out from epidermis, behind region of elongation. The 2 dark streaks farther back in the root are the beginning of xylem tissue. Note the spiral thickenings in the cells.

8. Part II: In Step G trim about a centimeter of stem under water, so conducting vessels are kept open.

9. In Step H add red food coloring or washable red ink to about 2 centimeters of water, until you get a deep color. Dye solution may be saved and used by other classes.

10. In Step I, for best results, celery stalk should be left standing in bright light. Cautiously scrape away the fleshy ribbed covering of a few vascular bundles with a fingernail. Look for the dye in the split and in the vascular bundles.

11. In Step J faint traces of dye may appear in the leaves by the end of the period.

Rise of Dye in Celery Stem

Time from Start	*Height of Dye*
6 minutes	5 cm
9 minutes	12 cm
12 minutes	14.5 cm
15 minutes	17 cm
24 minutes	21.5 cm
30 minutes	24 cm
36 minutes	26.5 cm

12. EXTRA. Prepare hand sectioned wet mount slides to show conducting cells of a "dyed" celery stem.
13. Part III: Handle cobalt chloride paper with forceps; try not to touch it.
14. Demonstrate technique. Using a live, intact geranium plant, put a strip of cobalt paper on a slide and place it on the lower surface of a leaf. Then place a strip of cobalt paper and a slide on the upper surface of the same leaf. Hold the 2 slides in place with tape and/or paper clips.
15. Caution students to handle plants gently.
16. Part IV: Use lettuce, or leaves from geranium or coleus plant. Two or 3 leaves should provide enough material for the whole class.
17. In Step N assist students in obtaining a piece of thin, transparent tissue.
18. In Steps P and R dry the bottom of the slide before examining under low power.
19. In Step Q demonstrate how to draw salt water drop under cover slip.

ANSWERS TO QUESTIONS

1. The water elevator is the process by which water travels up a stem.
2. Pulling of water into roots, stickiness of water in wood cells, and evaporation of water from leaves.
3. Water evaporates through the stomates of leaves.
4. Forests slow down water cycle by holding water in the ground and keeping it from running off rapidly. Crops speed up water cycle by transpiring more water than forests.
5. Cities, pavements, roads, and streets cause water to run off quickly instead of soaking into ground. Although people use more water, use does not speed up the water cycle.
6. Answers will vary.
7. Yes.
8. Answers will vary. See NOTES ON THE ACTIVITY.
9. Underside of leaf (which has greater concentration of stomates).
10. Closed.
11. By opening and closing, they can control the rate of evaporation from a leaf.

8 FOOD AND GAS AVAILABLE Pages (33) 225 - (36) 228

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. demonstrate that carbon dioxide is used during photosynthesis.
b. demonstrate that oxygen is given off during photosynthesis.
c. interpret Priestley's photosynthesis experiments.
d. state the gas exchange relationship between plants and animals.

TEACHING TIPS

1. Begin the chapter by asking students to explain how the earth is like a spaceship. Then review the fundamentals of photosynthesis as summarized in Section B and covered in "Action Biology," *Ecology*, Chapter 6.
2. The activity may be used as a classroom demonstration or as a laboratory exercise. Complete Sections C and D while waiting for results.
3. A simple invitation to inquiry is used in Section C to explain Priestley's photosynthesis experiments. Students may need hints to answer questions 4 to 9.
4. For questions 10 to 13, students should state the experiment number which illustrates the statement, and give reasons for their answers.
5. Experiment I provides indirect evidence that the absorption of CO_2 by elodea in the presence of light is caused by photosynthesis. Experiment II demonstrates that oxygen is given off during photosynthesis.

GAS ACTIVITY

Materials

Experiment I (per pair of students)
- cooled boiled water
- dropper bottle of phenol red
- elodea or other aquatic plant
- soda straw
- test tube rack
- 2 test tubes
- 2 rubber stoppers

marker
lamp (per class)

Experiment II (per group)
elodea
large jar or beaker
glass funnel
test tube
splint
soda straws
good light source

Preparation of Materials
To prepare a stock solution of 0.1% phenol red, dissolve 0.5 g phenol red in 500 ml of distilled water. Add a trace of ammonium hydroxide (about 1 drop) to turn the solution *deep pink*. The addition of a few drops of the stock solution to a test tube of boiled water should produce a faint pink color. If the pink color is too dark, simply dilute the stock solution until satisfactory. If the color is yellow, add additional ammonium hydroxide to the stock solution. The pH indicator bromthymol blue, prepared in a similar manner, may be substituted for phenol red.

Notes on the Activity
1. Experiment I: Elodea (Anachris) can be purchased from tropical fish pet stores. Grow it in your aquarium.
2. Give students necessary background. Phenol red is a pH indicator that is pink in alkaline (basic) solution and yellow in acid solution. Carbon dioxide is found in the breath, and is the only atmospheric gas which will form an acid when dissolved in water.

$$\underset{\substack{\text{carbon}\\ \uparrow\\ \text{dioxide}}}{CO_2} + \underset{\text{water}}{H_2O} \longrightarrow \underset{\text{carbonic acid}}{H_2CO_3}$$

3. Use jars or beakers as substitutes for test tube rack.
4. Have available *cooled* boiled water.
5. In Step B caution students to add only enough indicator to produce a light pink color. The same amount of indicator must be added to each tube.
6. In Step C caution students to breathe into the straw only until the solution in each tube *just turns* yellow. If too much carbon dioxide is put into solution, students may have to wait several days for the results of their experiment.
7. For Step D cut young sprigs of elodea to fit test tubes. At the conclusion of the experiment save plants and use them with other classes.
8. Students should put identifying marks on their test tubes.
9. In Step E place test tubes in bright sunlight or under bright incandescent light. Observe at 10 minute intervals. If using incandescent light, be careful not to kill the elodea by over-heating.
10. To supplement the experiment, a third test tube, prepared in a similar manner with an elodea sprig, can be placed in the dark, or covered with aluminum foil.
11. Summarize by asking students what the experiment demonstrates.
12. Experiment II: This experiment is best done as a classroom demonstration.
13. Obtain gallon size jars from cafeteria.
14. Set up the materials as shown in Step G. Fill a large beaker or jar with cooled boiled water. This eliminates dissolved gases. To provide carbon dioxide for the plants, have students bubble their breath into the water for 3 or 4 minutes with straws. Repeat the step several times during the experiment. Cut the ends of several sprigs of young elodea, and arrange them in the glass funnel so that their ends lie within or near the funnel stem. Tilt the funnel or place glass objects under it to allow adequate circulation of water around plants. Funnel should be completely submerged in water. Then, cover the upper stem of the funnel with a test tube *completely* filled with boiled water. Place the set-up under bright continuous light. After a while, tiny gas bubbles should form. After a number of hours, depending on conditions, enough gas should have collected for a test for oxygen.

ANSWERS TO QUESTIONS

1. Phenol red is yellow when CO_2 is present and pink when there is no CO_2.
2. During photosynthesis, phenol red turns pink in tube with plant. The plant uses up the CO_2 dissolved in the water. With carbon dioxide present, the water becomes slightly basic.
3. Plant produced oxygen by photosynthesis.
4. Candle stopped burning and mouse died.
5. They used up all the oxygen.
6. The plant died.
7. It used up carbon dioxide.
8. In Experiment IV the plant used up carbon dioxide. In Experiment V extra carbon dioxide produced while the candle was burning kept the plant alive.
9. Plant used carbon dioxide and produced oxygen, whereas the mouse used oxygen and produced carbon dioxide. The plant and mouse exchanged gases with each other.
10. Experiments III and VI.
11. Experiment VI.
12. Experiments I, V and possibly VI.
13. Experiments II and VI.

9 TO LIVE IS TO BELONG Pages (37) 229 - (40) 232

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. state the biological definition of a community and give examples.
b. state the definition of a food chain and give examples.
c. identify producers, consumers, and decomposers in a food chain.
d. distinguish between a first order consumer and a second order consumer.
e. describe a food web.
f. interpret a wolf-deer (predator-prey) graph.
g. describe ecological relationships in an urban community.
h. in a game situation, build food chains and see the effect of pollution on them.

Materials (per group of 2 or 3)

deck of index cards	pen
scissors	rubber band

Preparation of Materials
Decks of cards for ECOLOGY RUMMY can be made by cutting 3 × 5 index cards in half. Either cut the cards in advance with a paper cutter, or have students cut them in class. It usually takes about half a period to make the decks of cards. Store the decks for re-use.

TEACHING TIPS

1. This chapter deals with the relationships of producers, consumers, and decomposers in communities.
2. Section B presents food chains and a simple food web. Discuss additional examples with your class.
3. Section C asks the students to interpret a simple predator-prey relationship. Go over questions 5, 6, and 7 very carefully.
4. Section D discusses the ecological relationships that exist in an urban community. Ask your students to describe some food chains and food webs that occur in a city.
5. ECOLOGY RUMMY is an exciting, painless way for students to learn about food chains and the effect of pollution on them. Review the directions for the game with the class. The rules as written may be modified and interpreted by students or teachers as they see it. Keep in mind that the object of the game is not to win at cards but to understand the concept of food chains and the concept that we are all losers with pollution. Review these ecological concepts individually during the game, and in a post-game class discussion.

ANSWERS TO QUESTIONS

1. Lettuce is the producer, rabbits are the consumers, and bacteria are the decomposers.
2. Only green plants can make food. All other organisms are dependent on producers for food.
3. Deer eat plants directly; therefore they are first consumers. Wolves eat deer which have eaten plants. Thus, wolves are second consumers.
4. The girl is a second consumer of meat (hamburger) and a first consumer of wheat (bun).
5. About 87,000. With no wolves to kill the old, sick, and young deer, the population grew.
6. Deer population dropped to 25,000. The plants in the community could not support a large deer population. As food became scarce, many deer starved to death.
7. The deer population stayed at 12,500. When wolves were allowed to return they brought the deer population in balance with the food supply by killing the young, old, and sick deer.
8. Mosquitoes bite ("eat") humans who may have eaten Argentinian meat and Maine potatoes. Mice eat scraps of meat and potatoes found in food markets or garbage.

10 ONE THIRD OF A NATION Pages (41) 233 - (44) 236

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe the basic characteristics of a city.

b. list or show in a diagram how the various parts of a community are interrelated.
c. discuss the problems of urban-suburban areas.
d. complete an ENVIRONMENT WORKSHEET.

TEACHING TIPS

1. This chapter deals with urban ecology. Begin the lesson by having students delineate the boundaries of their local community and cite some of its basic characteristics. (See question 1.) Then relate the local community to the city or metropolitan area as a whole by having students name specific places and services that are used by all the people.
2. For Section C display a road map of your metropolitan area and have students locate the areas discussed in the section, especially those shown in the drawing on the bottom of page (42) 234.
3. In Section C discuss such questions as: What are the problems and concerns of the suburbs? The inner city? How are the problems and concerns similar? How do they differ? How can the city and its suburbs cooperate to make a better place for all people to live?
4. During class discussion, ask students to justify their answers to question 4.
5. Distribute 2 copies per student of the ENVIRONMENT WORKSHEET (black line master #3). Have students complete the worksheet by naming the neighborhood, checking appropriate categories, and filling in descriptions, locations, and uses. For the section on Traffic, they should state the location where they made their count. For the section on Soil, students should pick a sunny spot; thermometers and containers of water will be needed. For the section on Plants, under "Where Plants Grow," students should use abbreviations T for Tree, S for Shrubs, G for Grass, H for Herbs, and M for Mosses. Give students an opportunity to discuss completed worksheets.

Materials
ENVIRONMENT WORKSHEETS
laboratory thermometers
container of water

ANSWERS TO QUESTIONS

1. Answers will vary. Postman delivers family mail. Doctor takes care of my family. Milkman delivers my milk to supermarket. Parkman fixes park I play in. Librarian finds books for me. Druggist fills my prescriptions. Teacher teaches my class. Firemen put out fires.
2. Answers will vary. Old people don't like to travel. Many people fear leaving friendly surroundings. Children are too young to travel out of their neighborhood.
3. So they can receive and ship materials easily and cheaply.
4. Answers will vary.

11 THE CITY IS SICK Pages (45) 237 - (46) 238

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .
a. identify some of the major problems of our cities.
b. propose and justify solutions for some of the ills of a sick city.

TEACHING TIPS

1. The use of a simulation game is an exciting, painless way for students to learn about the complexities in solving problems confronting our cities.
2. Procedure:
a. After reading the chapter, elicit and list on the chalkboard some of the problems of the city. For example, litter, garbage disposal, traffic, air pollution, water pollution, sewage treatments, inadequate housing, lead poisoning, rats, roaches, hard drugs, noise levels, shortage of electrical power.
b. Divide the class into the Council and the various interest groups. The Council can be larger than the other groups. Try to have at least 1 verbal student in each group.
c. Each interest group should meet, elect a leader, and discuss the problems of the city in terms of its assigned roles. Based on the problems of the city, each group may make 3 proposals to the Council.
d. The Council should meet, select a Secretary and Chairman, and discuss the issues. Unfortunately, because of limited money the Council may accept no more than 6 proposals.
e. As each group in turn presents its proposals, the Secretary of the Council writes them on the board.
f. The Chairman of the Council conducts the hearing in an orderly fashion by recognizing only 1 speaker at a time. After a brief discussion period, during which anyone may speak for or

against a proposal, the Council votes on it by secret ballot. Alternatively, after discussing all proposals, the council can vote on them.

g. Have the whole class vote on the proposals to see if it agrees with the decisions of the Council.

12 WATER, WATER EVERYWHERE Pages (47) 239 - (52) 244

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe how water is used by people.
b. tell why cities are usually built near water.
c. list the causes of water pollution.
d. describe how bodies of water can oxidize limited amounts of waste.
e. describe what is happening to Lake Erie.
f. suggest ways to reduce and control water pollution.
g. perform water pollution tests on drinking water, simulated lake water, and simulated sewage.

TEACHING TIPS

1. Begin the topic by using questions 1 to 5 to stimulate a lively class discussion of the uses of water and the causes of water pollution.
2. In Section C stress that the natural process of oxidation purifies water of biological wastes. Discuss the following questions: How does excessive pollution affect the ability of a body of water to "purify itself"? What is happening to Lake Erie? Why?
3. For emphasis, list the students' answers to question 8 on the chalkboard.
4. The Water-Pollution-Test-Activity usually takes 2 laboratory periods to complete.
5. Distribute copies of the WATER POLLUTION WORKSHEET (blackline master #4) for students to complete during the activity.

WATER-POLLUTION-TEST-ACTIVITY

Materials (per pair of students)

3 small screw top vials or bottles
3 small beakers or jars
3 toothpicks
pH paper or litmus paper
microscope
microscope lamp
slide
cover slip
lens paper
4 test tubes
3 funnels
filter paper
plastic wrap
test tube rack
paper towels

(per group)

simulated lake water
simulated sewage
tap water
3 stirring rods or spoons
dropper bottle of methylene blue

Preparation of Materials

1. Prepare simulated sewage as follows: Seven days before the activity, empty the contents of a small can of sauerkraut into a large container. Depending on the size of the class, add 1 or 2 liters of tap water. Stir, cover, and place in the dark at room temperature. The mixture will undergo additional bacterial action. On the day of the activity, strain out most of the sauerkraut and stir into the liquid some dirt to give the "sewage" a slightly cloudy, brown appearance, enough liquid detergent so that it will foam when shaken, and, if necessary, a small amount of sodium sulfite to give it the odor of rotten eggs.
2. Prepare simulated lake water as follows: One day before the activity, dissolve half a cake of commercial baker's yeast or 1 package of dry yeast and 25 g glucose in 500 ml of water. Incubate overnight in a warm place. On the day of the activity, add additional water to bring volume to 2 liters. Then stir in enough liquid detergent so that it will foam when shaken, 100 ml of a mixture of sauerkraut and sauerkraut juice, if necessary some dilute hydrochloric acid to make it acidic, a small amount of filamentous algae (e.g., spirogyra), and some green food coloring for effect. Finally, stir some heavy motor oil into each container of lake water.
3. For preparation of methylene blue, see *Teacher's Guide, The Invisible World,* Chapter 4, or use the stock solution in Chapter 12.

Notes on the Activity

1. The microscope activities in "Action Biology," *The Invisible World,* Chapters 1 and 2, are necessary preparation for Step H of this activity.
2. Inform students that they should handle all samples as though they contained harmful bacteria and other microorganisms.
3. In Step A stirring ensures that students get a complete sample of the contents of the jar.
4. For Step D instruct students in the use of pH paper. Litmus paper may also be used. Ration the amount of paper used by each group.
5. *Alternatively,* in Step E fill test tube ⅔ full with water sample. Add 1 drop of methylene blue dye. After mixing, pour a thin layer of mineral oil over the surface to prevent oxygen

in air from reaching the dye. Perform procedure for all samples.

6. In the presence of oxygen, methylene blue is blue in color. When oxygen is removed from the water sample by the action of bacteria or other microorganisms, the methylene blue is bleached and becomes colorless. The degree and rapidity of bleaching is an indication of the concentration of microorganisms in the water sample.

7. It may be easier to postpone Step H, microscopic examination of samples, for another laboratory period. Be sure to demonstrate the preparation of an unstained wet mount.

8. Substitute paper towelling for filter paper in Step I. Trim it to fit funnels.

9. In Step J use food jars or cans as test tube racks.

10. After the activity, discuss the WATER POLLUTION WORKSHEET, and the rationale for the various tests.

11. The class can test actual water samples, if available.

WATER POLLUTION WORKSHEET

Test	*Results to Look for*	*Drinking Water*	*Lake Water*	*Sewage*
Color	Colorless Brownish Greenish Other (describe)	Colorless	Greenish	Brownish
Appearance	Clear Cloudy Other (describe)	Clear	Slightly cloudy thing floating in it	Cloudy
Odor	No odor Odor present (describe)	Chlorine	Oily	Rotten egg
Oil	No oil Oil present	None	Oil present	None
pH	Acid Basic Neutral	Acid	Acid	Acid
Dissolved oxygen	No loss of blue color Some loss of blue color How long for blue color to disappear	No loss of blue color	Some loss of blue color, time will vary	Loss of blue color, time will vary
Detergent	No foam Foam present How long for foam to disappear	No foam	Foam, time will vary	Foam, time will vary
Microscopic	No microbes Slight growth Heavy growth Draw typical microbes	None	Heavy growth	Heavy growth bacteria
Filter	Describe appearance of filter paper	Clear	Filamentous, "string things," oily	Brown stain
	Describe appearance of filtered water	Clear	Greenish & less cloudy	Brownish & less cloudy

Your conclusion about the quality of the water.

Drinking water OK. Lake water and sewage polluted. Sewage should be treated.

Give reasons for your conclusion.

Answers will vary.

ANSWERS TO QUESTIONS

1. Shortage of pure, fresh water.
2. Factories—shipping, cooling, and in certain industrial processes. Powerhouses—cooling reactors and generators. Ships and barges—transportation. Farms—growing plants and feeding livestock.
3. Swimming, fishing, boating, and water skiing.
4. Mainly for good transportation.
5. Mine runoff—acid wastes and other chemicals.
   Industry—waste water can vary greatly in its composition depending on the use of the water.
   Nuclear power plant—heat laden water (thermal pollution).
   Oil spill—from ships and offshore oil wells.
   Decaying vegetation—interferes in water oxidation process.
   Farm runoffs—from fertilizers, insecticides, herbicides, and animal wastes from feed lots.
   Home—human wastes (sewage) and detergents.
   Erosion—some naturally occurring, others man-made.
6. Water plants (algae) increase in number, crowd each other out, die, and decay. The decaying process uses up the dissolved oxygen in the water. Water animals requiring oxygen, such as fish, die.
7. Answers will vary.
8. Answers will vary.

13 DON'T BREATHE THE AIR Pages (53) 245 - (56) 248

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe the causes of air pollution.
b. name the gases and particles that are air pollutants.
c. tell why automobiles are said to be the main cause of air pollution.
d. define smog.
e. describe the causes of smog.
f. describe an inversion and its effect on smog.
g. describe how air pollution affects people and the environment.
h. describe how air pollution can be controlled.
i. perform some simple air pollution tests.

TEACHING TIPS

1. Begin the lesson by burning a piece of styrofoam, such as an egg carton, in a well ventilated room. The gaseous and particulate air pollution produced by this demonstration will amaze your students and arouse their interest.
2. Using the reading passage and drawing in Section A, elicit and list the causes of air pollution.
3. For Section B stress that odorless, tasteless, invisible carbon monoxide can kill you if you run a car in a closed garage. The high level of carbon monoxide on many roads during rush hour can affect the body.
4. On page (54) 246, the middle photograph shows rust damage on a truck caused by air pollution. A damaged lung is depicted in the bottom photograph.
5. In Sections C and D discuss the cause of smog and how an inversion intensifies its effect. Relate this to local conditions.
6. Ask students to interpret the cartoon in Section E. Discuss how air pollution affects people and the environment.

AIR POLLUTION ACTIVITY

Materials (per pair of students)
ruler
doublestick cellophane tape
index cards
cellophane tape
microscope
microscope lamp
lens paper
hand lens (optional)
waxed paper (optional)
Vaseline (optional)

(per group)
Smog Detector
smog test solution

Preparation of Materials

1. Use the diagram on page (56) 248 to build Smog Detectors. Rubber bulbs can be obtained from a drugstore.
2. Smog test solution:
   25 ml of distilled water
   0.5 g $Na_3 PO_4$
   1 g soluble starch dissolved in a little water
   5 g KI

dilute to 100 ml with distilled water
acidify with HCl to pH 6.8

Notes on the Activity

1. In Step A, the doublestick tape can be attached to clean microscope slides.
2. In Step C students must be careful not to let Vaseline touch the lens of the microscope. A hand lens, binocular dissecting microscope, or compound microscope may be used to count particles. Shine light on a Particle Counter of opaque material in order to examine it with a compound microscope. Have students describe the shape and color of the particles they see.
3. Particle Counters can also be made from such materials as white adhesive tape, Contac, or Vaseline coated waxed paper or microscope slides.
4. The *waxed paper technique* for detecting particulate matter is inexpensive, simple and easy to perform. Cut waxed paper into 8-cm square pieces. Use a sharp pencil or ball point pen and ruler to divide the paper into 1-cm squares. Scratch name on corner. Evenly smear the paper with a *thin* coat of Vaseline. Tape the Particle Counters in the room, on the floor, on the wall at different levels, on the window sill, in the hall, outside (place weights on corners), or any place else. After 24 hours, 48 hours, or even a week, count the particles with a hand lens or low power of a microscope.
5. For Step C you may wish to prepare some Particle Counters in advance for student examination.
6. Students will have to perform Step D outside of school.
7. The Smog Detector is best used as a group demonstration. Sulfur dioxide is the substance which reacts with the smog test solution.

ANSWERS TO QUESTIONS

1. Dust, dirt, soot and ashes from burning coal, oil and garbage, insecticide dust, asbestos, and particles from shoes and from the making of metals.
2. Sulfur dioxide, nitrogen oxides, carbon monoxide, gaseous hydrocarbons, and ozone.
3. Automobiles produce most of the gases that cause air pollution. They are probably 1 of the major causes of smog.
4. Smog is a heavy haze of irritating air pollutants. It can injure your lungs.
5. Answers will vary.
6. Answers will vary.
7. Answers will vary.
8. Answers will vary.

14 EVERYTHING MUST GO SOMEWHERE Pages (57) 249 - (60) 252

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. explain the meaning of the title of the chapter.
b. explain why wastes cannot be thrown away.
c. name the main kinds of solid waste.
d. explain the value of recycling garbage.
e. collect and sort litter in the classroom.

TEACHING TIPS

1. In teaching Section A, stress the "spaceship earth" concept.
2. In Section B mention that ¾ of solid wastes in the U.S. are of agricultural or mineral origin.
3. Relate Section C to the problems involved in the disposal of solid wastes in your locality.
4. Sections D and E emphasize recycling as 1 of the answers to solid waste disposal. In discussing these sections, draw upon the students' experiences with recycling.
5. You may want to assist students in organizing their own Crud Committee.
6. After the activity, hold a "litter rap." Discuss such questions as: Why is there a litter problem in school? In the neighborhood? What is a litterbug? Who are the worst offenders? What should be done with litterbugs? How can we stop littering?

LITTER ACTIVITY

Materials (per class)

scale
container for weighing
floor plan
assorted litter
soap
towels
rulers (optional)
graph paper (optional)

Notes on the Activity

1. In advance of the activity, collect a good assortment of litter. Spike the classroom with

it before class. Litter can be collected and weighed in paper bags.

2. Divide the room into sections by drawing chalk lines on the floor, or use a chalkboard diagram. Divide class into groups, and assign each group a section of the room.

3. For Step D write categories (e.g., notebook paper, newspaper, tissue, gum and candy wrapper, food wrapper, food waste, empty container, other) on the board for each group to record the kinds of litter they find.

4. EXTRA. Each group should count the number of pieces of litter in each category. What was the most common kind of litter? Least common? Each group should calculate the number of pieces of litter per square foot in their section of the room. Record results in a bar graph. Show the type of litter on the bottom of the graph and the number of pieces on the side.

5. If the activity is going to be repeated, have the class litter the room, adding their own contributions. Otherwise, dispose of litter in a suitable container.

6. After activity wash hands with soap and water.

ANSWERS TO QUESTIONS

1. Solid wastes must be disposed of in some way.
2. We cannot throw anything away because nothing ever leaves our planet. All we do is shift things from 1 place to another.
3. Agricultural wastes, mine wastes, household (mainly paper) wastes.
4. Recycling allows us to dispose of waste while we conserve materials such as aluminum, steel, and paper.
5. Garbage contains things that can be recycled, converted into fertilizer, or burned to produce electricity.
6. Answers will vary.
7. Answers will vary.
8. Paper and soda pop cans can be recycled.
9. Answers will vary. Use the wastepaper basket.

15 THE PEOPLE BOMB Pages (61) 253 - (64) 256

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. explain the causes of the population explosion.
b. interpret a graph of the growth of world population.
c. explain what is meant by zero population growth.
d. describe how people can deal with the population explosion.
e. discuss the potential results of overpopulation.
f. explain the significance of the green revolution.
g. calculate changes in population in the mythical city of Middletown.
h. graph Middletown's population.

TEACHING TIPS

1. In Section A use the figure to explain the factors that affect the size of a population.
2. In teaching Section B, ask students to explain the significance of the graph.
3. For Section C discuss the problems that may result from overpopulation in cities.
4. In discussing Sections E and F emphasize how the advances in modern agriculture have increased food production.
5. Carefully go over the formulas and examples on the POPULATION WORKSHEET. Relate the first formula (new population) to the diagram on page (61) 253. Students may work in small groups. Assist students who need help.

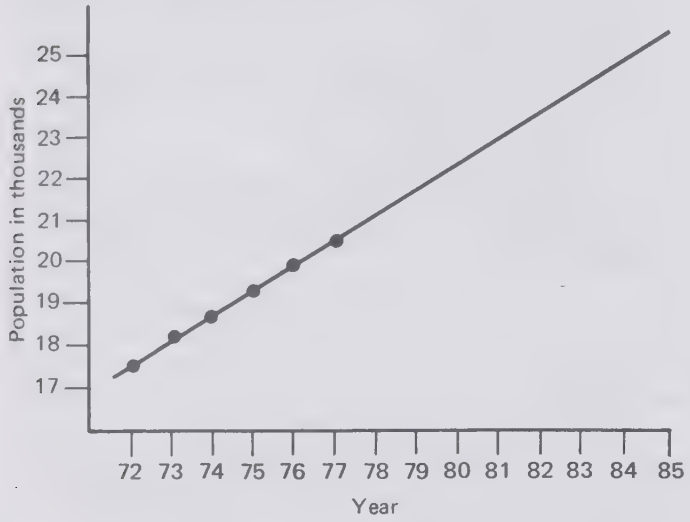
It is not necessary for students to find the new population and population change for each year in the table for them to understand how these figures are calculated. After a reasonable period of time, place the answers on the board and assist students in graphing Middletown's population.

Materials (per student)
graph paper
pencils
rulers

POPULATION WORKSHEET

Middletown Population Figures

Year	*Births*	*People Moving In*	*Deaths*	*People Moving out*	*Population Change*	*Population at End of Year*
1972						17,538
1973	811	132	267	134	+542	18,080
1974	803	141	259	149	+536	18,616
1975	827	155	241	164	+577	19,193
1976	849	128	262	158	+557	19,750
1977	861	118	215	131	+633	20,383



1. It is growing. Graph slants upward.
2. 569.
3. 24,935 or approximately 25,000.
4. Answers will vary. Disaster, people moving out, people moving in, etc.
5. Population will decrease.
6. Answers will vary.

ANSWERS TO QUESTIONS

1. 230 years, 100 years.
2. Graph (slope) is going steeply upward.
3. Just extend the line.
4. The population drops because fewer than 2 children will survive to reproduce.
5. Answers will vary. Tension, violence, and aggression tend to increase. Standard of living decreases. People lack privacy. Pollution increases.
6. Answers will vary.
7. It means more food can be grown on the same amount of land.
8. Rillieux invented a machine which reduced the amount of fuel and the number of people required to make sugar. Carver developed hundreds of uses for peanuts and peanut plants. Borlaug's new plant breeds produce more food on the same land.

SUPPLIES AND EQUIPMENT

Large Equipment

Aquaria
Blender
Hot plate, electric
Incubator (optional)
Lamps, gooseneck or high intensity
Lamps, microscope
Microscopes, compound
Microscopes, dissecting

Small Equipment

Aquarium equipment
Battery jar
Beakers, assorted sizes
Clamps, pinch
Corks, assorted sizes
Cover slips
Dissecting needles
Dissecting pans
Dropper bottles
Droppers
Eggbeater
Filter paper
Forceps
Funnels, glass
Funnels, small metal
Hammers
Hand lenses
Lens paper
Litmus paper
Mixer, electric (optional)
Mortar and pestle
Petri dishes
pH paper (optional)
Pipette, 10 ml (optional)
Razor blades, single-edged
Rubber bulb, large
Rubber stoppers, assorted sizes
Rulers
Saw, keyhole or coping (optional)
Scale
Scissors
Slides, microscope
Splints, wood
Test tube rack
Test tubes, assorted sizes
Thermometers
Tongs
Tubing, rubber
Vials, with covers

Chemicals

Acetone
Acid, hydrochloric
Alcohol, isopropyl or ethanol
Ammonium hydroxide
Benzene (optional)
Brilliant green stain

Cobalt chloride paper
Glucose
Iodine, crystalline (optional)
Lugol's iodine solution
Methylene blue stain
Omniwax (optional)
Petroleum ether
Phenol red indicator
Potassium iodide
Sodium chloride
Sodium phosphate
Sodium sulfite (optional)
Starch

Biological Materials

Branches, cut up
Creeping bent grass seed
Earthworms (live)
Earthworms (preserved)
Elodea
Geranium plant
Spinach leaves, fresh or frozen
Tree trunk, longitudinal and cross sections (optional)
Variegated coleus plants
Yeast, cake or package

Consumables Obtainable Locally

Baby food jars with lids
Bowls
Celery, fresh
Classified ad sections
Detergent, liquid
Flashlight
Food coloring, assorted colors
Graph paper
Index cards (3 × 5)
Ink, black
Jars, large
Kitchen baster (optional)
Labels (optional)
Lettuce
Markers, glass
Nails
Newspapers
Oil, heavy motor
Paper clips (optional)
Paper towels
Pencils
Pins, straight
Plastic wrap
Q-Tips
Red ink, washable
Sauerkraut, can of
Soda straws
Spoons, plastic
Styrofoam, cup or egg carton
Tape, cellophane
Tape, doublestick cellophane
Thumb tacks
Toothpicks, flat
Vaseline
Vinegar, white
Wallpaper paste
Waxed paper
Window screening
Wood scraps, hardwood and softwood

AUDIOVISUAL MATERIALS

For meaning of abbreviations, see *Teacher's Guide,* page 131.

Air is for Breathing. Color, 27 min., Shell Oil Co. (Objective presentation.)

Answer Is Clear. Color, 14 min., Modern Talking Pictures. (Discusses air pollution and its prevention.)

Around a Big Lake. Color, 17 min., International Film Bureau. (Ecology of a lake.)

The Biosphere. Film Loop, Hubbard.

The Cave Community. Color or B&W, 17 min., EBE. (Interesting ecological study of an unchanging environment.)

The City as a Community. Filmstrip, MGH.

Collector's Item. Color, 32 min., Data Films. (Depicts refuse collection and disposal in Los Angeles.)

The Community. Color or B&W, 11 min., EBE. (Food webs, and the roles of various organisms in the community.)

Ecosystem Processes. Film Loop, Hubbard.

Effects of Crowding on Rats. Film Loop, Harper and Row.

The Food Cycle and Food Chains. Color or B&W, 11 min., Coronet. (Excellent presentation.)

The Garbage Explosion. Color, 15 min., EBE. (Excellent.)

How Green Plants Make and Use Food. Color or B&W, 11 min., Coronet. (Elementary survey of photosynthesis and plant physiology.)

Leaves. B&W, 28 min., MGH-AIBS Series. (Adaptation of leaves for photosynthesis, transport, and support.)

Life in a Cubic Foot of Soil. Color or B&W, 11 min., Coronet. (Living components of soil.)

Life in a Fallen-Log Microcommunity. Filmstrip, Society for Visual Education.

Life of a Plant. Color, 11 min., EBE. (Life cycle of the pea plant, and the role of its various organs.)

The Living Desert. Color, 75 min., Walt Disney. (Simple but lovely film on desert ecology.)

Look to the Land. Color or B&W, 21 min., EBE. (A forceful statement of the need for conservation.)

Man's Problem. Color, 20 min., EBE. (Discusses water use, shortage of fresh water, and conservation of water.)

Measuring Rate of Photosynthesis. Film Loop, BFA.

Nature's Half Acre. Color, 33 min., Walt Disney. (Stresses seasonal changes in natural communities. The commentary is unsophisticated, but ecological concepts are implicit in this beautiful film.)

Nitrogen Cycle. B&W, 12 min., Univ. (Full presentation of this important geochemical cycle.)

Pathways of Water in Herbaceous Plants. Film Loop, BFA.

Pathways of Water in Woody Plants. Film Loop, BFA.

Photosynthesis. Color, 21 min., EBE. (Shows products, and modern methods of investigation.)

Photosynthesis: Carbon Dioxide Requirement, I and II. Film Loop, EBE.

Photosynthesis: Chlorophyll Requirement. Film Loop, EBE.

Photosynthesis: Factors Affecting Oxygen Production. Film Loop, EBE.

Plant-Animal Communities: The Changing Balance of Nature. Color or B&W, 13 min., Coronet. (Discusses biomes, ecological cycles, and conservation.)

Plant Life at Work. Color, 11 min., Moody. (Major processes in plant physiology.)

The Pond. Color, 20 min., International Film Bureau. (Relationships among organisms living above and below the water surface.)

The Pond and the City. Color, 16 min., EBE. (Ecology and conservation within the city.)

Population Ecology. Color, 21 min., EBE. (Excellent.)

The Prairie. Color, 18 min., International Film Bureau. (Integrated picture of the prairie community.)

Problems of Conservation—Air. Color or B&W, 15 min., EBE. (Discusses the effects of air pollution on health and property, and technological and legislative controls.)

Pure Water and Public Health. Color, 28 min., Modern Talking Pictures. (Describes how water supply systems work and presents facts about possible water shortages.)

The Redwood Trees. Color, 15 min., Arthur Barr Productions. (Emphasizes ecology.)

The River Must Live. Color, 21 min., Shell Oil Co. (Excellent presentation of water pollution problems.)

Roots of Plants (Second Edition). Color or B&W, 11 min., EBE. (Functions of different kinds of roots.)

Segmentation: The Annelid Worms. Color or B&W, 16 min., EBE. (Structure, functions, classification and evolution of the group.)

Stems. Color or B&W, 28 min., MGH-AIBS Series. (Xylem, phloem, structure of stems.)

The Strand Breaks. Color, 16 min., EBE. (What happens when ecological principles are ignored.)

The Strand Grows. Color, 16 min., EBE. (Interrelationships of organisms in web of life.)

Succession: From Sand Dune to Forest. Color or B&W, 16 min., EBE. (Investigation of the Lake Michigan dunes, from which the principle of succession was largely derived.)

Transpiration: Water Loss in the Leaf. Film Loop, EBE.

What Is Ecology? Color or B&W, 11 min., EBE. (Brief introduction to ecology; shows main biomes of the world.)

World at Your Feet. Color, 23 min., International Film Bureau. (Ecology of the soil, and soil management.)

DOING THEIR THING

CONTENTS

PLAN AHEAD for the following lessons:

Chapter 1 Obtain snails. Duplicate copies of concentric circles.
2 Obtain mealworms.
3 Obtain live frogs.
4 Use live frogs from Chapter 3, or obtain preserved frogs. Duplicate copies of GROUPING WORKSHEET.
5 Duplicate copies of TANGRAM WORKSHEET and FIELD WORKSHEET.
6 Obtain yardsticks.
10 Obtain Daphnia or Tubifex, and drugs.
11 Have students bring in decks of playing cards.
12 Have students bring in decks of playing cards.
13 Duplicate copies of TABLE OF GUESSES AND ACTUAL CARDS.

1 MOLLUSKS Pages (3) 259 - (6) 262

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. list the general characteristics of mollusks.

b. identify several kinds of mollusks.
c. describe 1 mollusk in detail.
d. investigate the behavior of a snail.

TEACHING TIPS

1. Ask students to: describe the general characteristics of mollusks; list mollusks that people eat; describe how snails are markedly different from other animals; like other animals.
2. Either as enrichment, or as an alternate to the snail activity, have students study oysters, clams, or squids. These mollusks can be readily obtained from most fish stores, especially in Italian neighborhoods.

SNAIL ACTIVITY

Materials (per pair of students)
snail
glass plate, 10 to 12 centimeters square, with edges taped for safety
lettuce
hand lens
orange peel (optional)
oatmeal (optional)
compass (optional)
ruler (optional)
watch or clock (optional)

Notes on the Activity

1. Introduce this activity by stressing that careful observation is a fruitful method of studying living things. Students should try to see how much they can learn about snails from observation and simple experimentation.
2. A useful creature for this exercise is the edible Burgundy snail, *Helix aspersa*. This snail is imported, and is sometimes available in fish markets in major cities. A pound contains about 100 snails. This is enough for a class, and can be used over and over again for 2 or 3 days. Other land snails are available at higher prices from biological supply houses.
3. The snails will arrive dry, with the aperture of each shell closed by a mucous membrane. They can live for months in this state. Place the snails you wish to "activate" into a jar of cold water, shake, and pour off the water. Repeat 2 or 3 times. Then distribute the snails in several covered battery jars with a little water and a few lettuce leaves in the bottom of each. Within half an hour many of the snails will emerge from their shells and crawl up the glass. Take the jar into class, and distribute the snails by picking them up gently, 1 at a time, and placing each on a glass plate. If the snail withdraws into its shell, have the student return it to the jar and take another.
4. Other gastropods may be substituted for *Helix*, including local land and pond snails, aquarium mystery snails, slugs, and marine forms such as periwinkles or whelks. Mystery snails are available in pet shops and in pet departments of department and variety stores.
5. As the snails die, dispose of them quickly; dead mollusks become malodorous very quickly.
6. Remind the students that snails are living creatures and can be hurt. Handle them gently.
7. In Step A students should turn the plate on edge and observe what the snail does. The part of the body on which the snail moves is called the foot.
8. In Step B place a small piece of lettuce directly in front of the snail. A hand lens may help the student see what is happening. To find out what else the snail will eat, students can try feeding it orange peel, oatmeal, paper, cardboard, or anything else.
9. EXTRA. Challenge your class to find how fast a snail can walk. To time the snail's rate of movement on glass, place a duplicated copy of paper with 6-mm ($\frac{1}{4}$-inch) concentric circles (blackline master #5) under the glass plate so that the snail is in the center of the circles. The rate of movement will vary widely; 5 cm (2 inches) per minute is a very rough average.

Can snails travel faster on sandpaper than on glass? Draw concentric circles on sandpaper, place the snail in the center of the circles, and time its motion.

ANSWERS TO QUESTIONS

1. All those labeled in the drawing on p. 260 (4) except tentacles and mantle cavity.
2. Secreted by clams or oysters around irritating particles such as sand grains.
3. Mollusks have soft bodies, hard shells, and no appendages. Crustaceans have external skeletons which are shed, and jointed appendages.
4. Answers will vary.
5. It crawls on its foot. When the plate is turned, the snail turns and climbs upward. The weight of its shell seems to pull it in this direction.
6. The tongue draws the food into the mouth. (It will eat a variety of plant matter.)
7. When touched, the feelers pull in like the fingers of a glove.
8. The black spots on the end of the feelers are eyes.
9. The snail seems to fold up and withdraw into its shell. It slowly leaves the shell, with the head and foot coming out first.

2 THE CREEPY CRAWLERS Pages (7) 263 - (10) 266

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. name several examples of jointed-leg animals (arthropods).
b. describe the general characteristics of jointed-leg animals.
c. distinguish between insects and spiders.
d. distinguish between centipedes and millipedes.
e. describe the life cycle of the grain beetle (*Tenebrio*).
f. name and describe several crustaceans.
g. investigate the behavior of the mealworm.

TEACHING TIPS

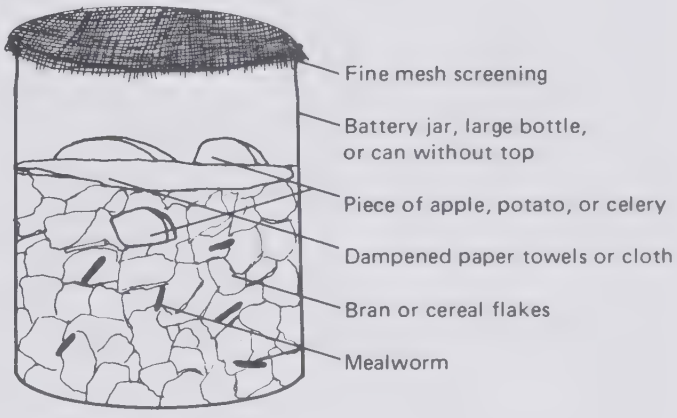
Have students compare the behavior of mealworms to the behavior of other animals, e.g., snails.

MEALWORM ACTIVITY

Materials (per pair of students)
mealworm, live
Petri dish, plastic
paper towel
scissors
materials for walls: cardboard, heavy paper, aluminum foil, microscope slide, plastic strips, etc.
masking tape or transparent tape
food: bran, other breakfast cereals, apple, celery, potato, banana, lettuce, etc.
dropper bottle of water
hand lens
ruler
sharpened pencil
straw
forceps
small test tube
beaker of ice and water (2 or 3 per room)
binocular microscope (1 or 2 per room)

Notes on the Activity

1. Mealworms can be obtained from local tropical fish stores, pet shops, pet departments of department and variety stores, or at higher prices from biological supply houses. Purchase at least 100 or 200 mealworms, since not all of them will be active. If not abused, they can be used by several classes.
2. Mealworms are used to feed such animals as monkeys, frogs, fish, and salamanders. They can be easily cultured, requiring only a container half filled with bran or other cereal flakes, and a dark, cool place. Fresh bran should be added when most of the old bran becomes reduced to powder. For moisture, small pieces of apple or potato can be placed in or on the bran.



MEALWORM CULTURE

3. Mealworms should be kept in the dark, and starved for 24 hours before the activity. Expect squealing and negative comments when the students receive them. Remind students that mealworms are living creatures and can easily be hurt. Handle them gently with the forceps. It is best to use smaller, younger, active mealworms for this lab. Students should return "lethargic" mealworms to the culture. If you are not getting good results, try placing 2 mealworms in a Petri dish, as this often "stimulates" them.
4. Set up a binocular microscope so that students may examine their mealworms in detail.
5. For Step A use the smaller half of a glass or plastic Petri dish to draw a circle on a paper towel. Then cut the paper circle to fit inside the larger half of the Petri dish.
6. In Step C students should *gently* touch the legs, hind end, sides, back, and head of the mealworm with a pencil, toothpick, or finger.
7. For Step E any or all of the following materials and tools can be used for wall building: cardboard, aluminum foil, heavy paper, plastic strips, plastic wrap, microscope slides, masking tape, transparent tape, and scissors.
8. Students can draw the mealworm's path in Steps F and I by following it around the paper with a pencil. In Step I caution students

against guiding the mealworm's direction by pushing it with a pencil. The length of the drawn path can be measured with a ruler.

9. Some of the ways students can get mealworms to walk backwards are: applying chemicals such as vinegar, ammonia, etc., with a Q-Tip; touching with pin, pencil, hair, etc.; blowing on it through a straw; using such stimuli as smoke, heat, light, or electric shock from a battery.

10. In Step H gently blow through a straw at the sides, head, back, and hind end of a mealworm.

11. In Step I the pile of bran should be added to 1 side of the mealworm's dish. They will usually eat almost any dry carbohydrate plant product, and are attracted by moisture to such foods as apples, bananas, celery, and lettuce (Step J).

12. To cool the mealworm in Step L, place it in a small test tube in a beaker of ice and water. After a few minutes return the cooled mealworm to the Petri dish and observe its behavior as it warms up.

13. Expect the answers on the MEALWORM BEHAVIOR table to vary greatly.

Mealworm Behavior

Stimulus	*Mealworm's Response*
Touch side with hair	moves away
Reaches side of dish	backs away
Wall of cardboard	follows side of wall
Touch head with finger, vinegar on Q-Tip, and blowing on head	walks backward
Food (bran)	attracted to it, eats it, burrows into it
Water	stays on wet side of paper more than on dry side
Cold	stops walking, sluggish
Warmth	becomes active, starts moving around

ANSWERS TO QUESTIONS

1. Insect's body has 3 main parts. Spider's body has 2 main parts.
2. Insect has 3 pairs of legs. Spider has 4 pairs of legs.
3. Insect has feelers.
4. Answers will vary.
5. It moves away when touched.
6. Legs work together in a step-like manner.
7. When it reaches the side of dish, it backs away or crawls along it.
8. Answers will vary greatly.
9. Yes, if it is slanted slightly.
10. By blowing on its head, and by touching it.
11. It seems to wander around the dish aimlessly until it gets close to the bran; then it heads straight for the bran.
12. The mealworm eats the bran and burrows into it.
13. It eats all breakfast cereals.

3 THE FROG Pages (11) 267 - (16) 272

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe the characteristics of amphibians.
b. define the terms cold-blooded, hibernation, and adapted.
c. describe how a frog is adapted to a land life and an amphibian life.
d. investigate the behavior of a frog.
e. relate the structure of the frog's legs to jumping and to swimming.
f. locate the third eyelid, and explain how the frog uses it under water.
g. describe how the frog catches its food.
h. explain how a frog breathes.
i. describe how a frog is camouflaged.

1. Help students having difficulty with the LIVE FROG ACTIVITY. In reviewing answers to the questions, emphasize correlation of structure with environmental adaptations.

2. For the GROUPING WORKSHEET, give each student a pair of scissors and a copy of Blackline Master No. 6 in the Teacher's Guide. Students can cut out and paste up the animals. Alternatively, though not as satisfactorily, students can do the grouping by listing the numbers of the animals. Work in teams of 4.

LIVE FROG ACTIVITY

Materials

(per group of 2 or 4)	(per class)
living frog in covered jar with water	covered battery jar with dry leaves
mealworms	water-filled aquarium
forceps	fish net
tongue depressor	clock
Q-Tip	paper towels
	meterstick

Notes on the Activity

1. Live frogs may be purchased from a biological supply house. When you receive them, rinse them in cold running water. Store them in a little water in a non-airtight container, and place in the refrigerator.Rinse frogs daily.

Live frogs are expensive, and often unavailable, especially in spring. It is best to do this activity in the fall, when frogs are most available. Five-centimeter long grass frogs (*Rana pipiens*), which are relatively cheap, are adequate for the activity. Graska Biological, Oshkosh, Wisconsin 54901, has been found to be an economical source.

2. Students entering a biology course traditionally look forward to dissecting a frog. It is wise at this point to play down dissection in favor of observation of the living animal. Stress that in observing the frog's structure and behavior, students should look for characteristics that function in helping the animal survive.

3. Emphasize that small animals such as the frog are neither dangerous nor disgusting and can be handled safely and easily. Also emphasize humane considerations in handling frogs.

4. If some students are reluctant to handle the frog, do not force them. Tell them simply to stand back and watch. You will probably see these students edging forward, and in many cases eventually participating actively. Overcoming the attitude of aversion to small animals, or the affected aversion which is common among girls in adolescence, is fully as important as anything else that this activity can achieve.

5. Warn your students not to allow their frogs to be out of a moist environment for more than 5 minutes at a time.

6. In Steps A and B you can catch the frog by putting your hand over its head from the front, and getting a firm grip on the body. Then straighten out the hind legs with your other hand and wrap this hand firmly around the body just behind the forelegs. Since you can expect frogs to "escape," have your students practice catching them.

7. In Step D use a moistened Q-Tip to touch the frog's eye.

8. In Step E, by chin movements is meant the number of times the flap of skin under the chin moves up and down in 1 minute.

9. For Step G, sometimes it is best to place the frog in, instead of on, the leaves.

10. For Step I draw a small chalk circle on the floor. Frogs are placed in the circle. When the frog jumps out of the circle, mark with an X the spot where the frog lands. Measure the distance from the circle to the X. Students may repeat 2 more times. If necessary, prod frogs gently in order to encourage jumping activity. List on the board the longest distance that each group's frog jumps.

11. After Step L catch the frog with the fish net.

12. In Step M students will have to be quiet and still in order to get the frog to eat.

13. Also in Step M, the frog has 2 small teeth in the anterior roof of the mouth.

14. In Step P place the frog on its back and "hypnotize" it by stroking the belly.

ANSWERS TO QUESTIONS

1. Frog's nostrils are on upper surface, set back from the tip of the head; they can open and close. The ears are flat, round eardrums, with no outer ear. The 2 outer eyelids are usually the color of the frog's body. The third eyelid is a transparent membrane. When the eyelids close, the eye is drawn into the head.

2. Up to 25 nostril movements per minute. Chin movements will range from 0 to 5 times the number of nostril movements.

3. With its nostrils open, the frog lowers the flesh of the lower jaw, dragging air into the mouth. The nostrils are then closed, the lower jaw is raised, and the air is forced down the trachea into the lungs. (Explain how the diaphragm helps us breathe. For a description of the diaphragm, refer to "Action Biology," *Keeping Alive*, Chapter 12.)

4. The spotted skin of the back is much darker than belly skin. When the frog is in water, a fish will mistake the white belly for sky. Its greenish brown skin blends in with the vegetation and protects it from predators.

5. The skin turns from brown to green to blend in with the leaves.

6. The long, muscular, jointed hind legs are folded under the body; when extended, they provide the force that propels the frog forward. The front legs support the body and absorb the impact of landing.

7. The frog rests in the water at about a 30 degree angle to the surface, with its eyes and nostrils out of the water and its hind legs

extended. This allows the frog to breathe and catch food while watching for danger.

8. The frog swims with its hind legs; we swim with both our arms and legs. The frog is a good swimmer because it has long, muscular hind legs with webbed feet.

9. No. The frog can absorb oxygen through its wet skin.

10. The third eyelid is transparent. It protects the eye, while allowing the frog to see under water.

11. The long, sticky tongue is attached in the front of the mouth, and flips out to catch the mealworm.

12. Adaptations to life on land: protective coloration, lungs, and powerful jumping legs. Adaptations to life in the water: powerful legs with webbed feet, wet skin through which it breathes, nostrils that can close when under water, third transparent eyelid for seeing under water, and ability to float with nostrils and eyes above water.

4 DISSECTING THE FROG Pages (17) 273 - (20) 276

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. dissect a frog.
b. identify the internal organs of the frog.
c. artificially stimulate a nerve and generate a nerve impulse.

FROG DISSECTION ACTIVITY

Materials (per group of 2 or 4)
preserved or pithed frog
scalpel
forceps
scissors
dissecting needle
dissecting pins
dissecting tray
paper towels
small dish or $\frac{1}{2}$ of a small Petri dish
medicine dropper
salt solution (frog Ringer's)

Preparation of Materials

To prepare the salt (frog Ringer's) solution, dissolve in 1 liter of water 7.5 g sodium chloride, 0.14 g potassium chloride, 0.12 g calcium chloride, and 0.20 g sodium bicarbonate.

Notes on the Activity

1. This exercise may well be 1 of the high spots of the year's laboratory work. Students generally look forward with anticipation to frog dissection, which they have heard about. Do not force reluctant students to participate. Let them linger on the outskirts of the group, and before the class is over they may find themselves involved in the work. Inculcation of proper attitudes is an important outcome of this exercise. The teacher's manner will help develop in the students a serious and matter-of-fact attitude toward animal dissection.

2. Kill the frog by pithing before class and out of the students' presence. After using a blunt probe to destroy both the brain and the spinal cord, rinse away all traces of blood with cold running water. Alternatively, kill the frog by briskly striking its head against the edge of a table.

3. If at all possible, the dissection should be completed within 1 period. Frogs can be wrapped in wet paper towels at the end of the period, placed in the refrigerator, and used for another day or 2. However, on the second day the frogs are likely to look far less attractive, and interest may well be lessened.

4. Freshly killed frogs are preferable to preserved material. If preserved frogs are used, omit Steps M and S.

5. A single-edged razor blade is just as good, if not better, than most classroom scalpels.

6. Students may need assistance for Steps D, G, H, and L.

7. In Step M the heart should be placed in a small dish and kept moist with frog Ringer's solution.

8. In Step N the medicine dropper should be placed deep in the windpipe through the mouth.

ANSWERS TO QUESTIONS

1. The tongue is attached to the front end of the mouth.

2. The leg muscles will contract.

5 TANGRAM ZOO Pages (21) 277 - (24) 280

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. distinguish between vertebrates and invertebrates, and give examples of each.
b. list the 5 types of vertebrates.
c. tell the similarities between birds and mammals.
d. state the characteristics of mammals.
e. describe how birds are adapted for flight.
f. observe and perform a field study of animal behavior.
g. define the terms pecking order and territoriality.
h. compare and contrast pecking orders in birds with human hierarchies in school, the army, teenage groups, business, or government.
i. compare and contrast territoriality in animals with the manner in which man accumulates and defends property.

TEACHING TIPS

1. Discuss pecking order and territoriality in some detail. Social hierarchies, such as pecking orders in birds and other animals, involve ranking, with each member of the hierarchy dominant over all those of lower rank and submissive to all those of higher rank. Students may compare and contrast pecking orders in birds with hierarchy or rank in human social organizations. Does animal behavior throw any light on human behavior?

Territoriality involves the occupation and defense of definite areas. It is instinctive. In many animals it operates only during the mating season. Compare and contrast territoriality in animals with the manner in which men and nations accumulate and defend land and property, and with gang turfs. Be wary of drawing crude analogies. Is biological inheritance of aggressiveness and territoriality operative in man, or are there other factors? Konrad Lorenz asserts that human aggressiveness is based on biological inheritance. Others feel that aggressiveness is socially acquired in certain cultures, and is not an innate human trait.

2. Distribute copies of the FIELD WORKSHEET (blackline master #8). After completing the FIELD WORKSHEET, summarize the chapter with this open question: How does the study of animal behavior help us understand our own behavior? Caution the students against drawing facile, broad conclusions on the basis of scanty evidence.

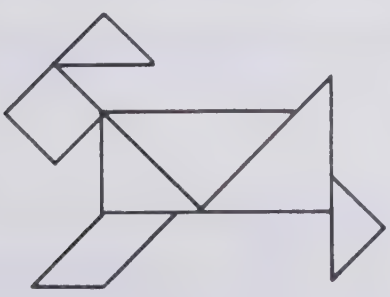
FIELD WORKSHEET

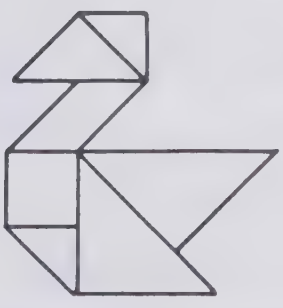
The FIELD WORKSHEET can be used to study animal behavior in a park or zoo (e.g., monkeys, ducks, and large cats). It can also be used to describe a pet's behavior. Students should discuss their observations. They may consider these questions: How are animal behavior and human behavior similar? How are they different?

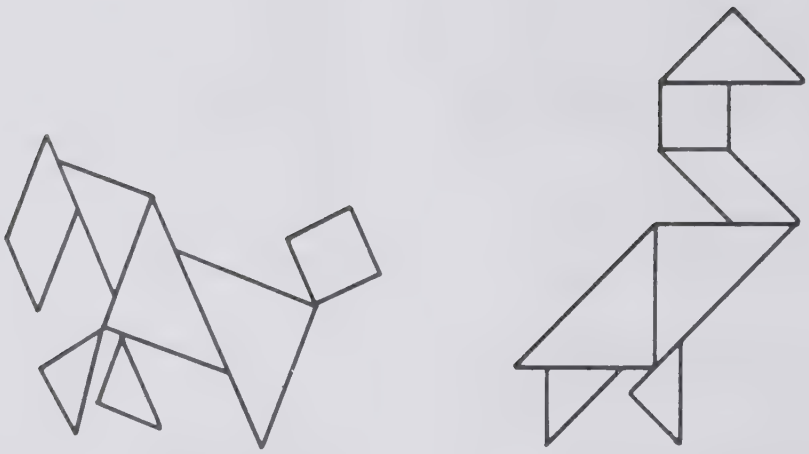
TANGRAM WORKSHEET

Materials
paper
scissors

You may want to distribute copies of the tangram puzzle pieces (blackline master #7). Tangrams can be made from the black animal silhouettes shown on page (23) 279 as follows:







FIELD WORKSHEET

Kind of Animal Observed Pigeons
Number of Animals Observed 17 or 18
Place Entrance to Jefferson Park
Length of Time Observed 35 minutes
Date observed April 28

Kind of Behavior	*Comments*
Feeding	Lady fed them bread for 5 minutes. Birds also pecked at scraps on ground.
Running or walking around	Flew or walked around the park.
Resting or sleeping	Perched on buildings and on top of monument.
Fighting, threatening, fleeing	Some big pigeons chased away others that were pecking at food. Birds ran or flew away when other animals came close.
Courting or mating	Some males flew after females, then ran around in front of females, bowing and fluffing their breast feathers. Females mostly turned away. Saw 1 example of mating: female squatted, male mounted her for a few seconds while flapping his wings.
Getting or receiving attention	Did not see.
Exploring, investigating, playing	Several birds pecked at brightly colored paper.
Imitating another animal	Did not see.

ANSWERS TO QUESTIONS

1. Vertebrates have a backbone; invertebrates do not.
2. Humans have hair, nurse their young, and develop their babies internally.
3. Feathered wings, good eyesight, light hollow bones, and strong muscles make birds good fliers.
4. Answers will vary. The tangram animals pictured around the perimeter of page (23) 279 are: giraffe, dog, flying bird, bird, cat, horse, running bird, bat, crocodile, polar bear, and duck.

6 THE AUTOMATIC PERSON Pages (25) 281 - (28) 284

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. define the term reflex.
b. give examples of reflexes that protect the human body.
c. explain how a reflex works.
d. define the terms stimulus and response.
e. demonstrate tests for several reflexes.
f. describe the basic parts of the nervous system: brain, spinal cord, and nerves.

TEACHING TIPS

Use models, charts, or transparencies to review the parts of the central nervous system.

REFLEX WORKSHEET

Materials
spool of thread
scissors
clear plastic sheet or plastic wrap

Response

a. Iris Reflex. It will be noted that the pupils, dilated as a result of the time spent in darkness, will suddenly contract in response to the stimulus of light.
b. Knee Reflex. The leg will swing outward.
c. Sneeze Reflex. Sneeze. (Note that inside of nostril should be tickled with a clean piece of thread.)
d. Toe Reflex. The toes will curl downward.
e. Arm Reflex. Arm will rise.
f. Foot-Jerk Reflex. Foot bends.
g. Blinking Reflex. Blinking.
h. Eye-Neck Reflex. The pupils contract. In order to demonstrate this reflex, sometimes it is necessary for a third person to pinch unexpectedly the back of the subject's neck.

ANSWERS TO QUESTIONS

1. Blinking, response to hot object, coughing, sneezing, gagging, and vomiting reflex.
2. Beating of heart, working of stomach, and breathing reflex.

7 SEEING THINGS Pages (29) 285 - (34) 290

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. define the terms perceive and illusion.
b. explain the basis for optical illusions.
c. describe in simple terms how we see with our brain.
d. explain the basis for depth perception.
e. test for depth perception and for side vision.
f. describe several optical illusions.
g. explain how optical illusions help us perceive moving pictures or television images.

TEACHING TIPS

1. Use the drawing on page (29) 285 to discuss seeing with the brain.
2. Some students might enjoy making flip books out of index cards or slips of paper. In order to produce the illusion of movement, each drawing in a series should show a successive small difference from the preceding one.
3. Ask students to explain how the artist created the illusion of distance in the drawing on page (31) 287.
4. Correlate side vision and depth perception with driver safety.

VISION ACTIVITY

Materials (per group of 2 or 3)
for side vision:
2 metersticks
transparent tape
brightly colored construction paper
scissors
narrow jar or glass
for depth perception:
meterstick
pencil
small object such as toy car or chalkboard eraser

Notes on the Activity

1. Demonstrate each test before the class performs the activity.

2. Half the class can test side vision while the rest of the class tests depth perception. Then switch groups.

3. For Step C brightly colored 5-cm high objects or letters cut from construction paper will be needed. Letters such as E, F, H, L, T, V, and Z, or objects such as triangles, squares, rectangles, and circles are easy to make and can be precut to save time.

4. In Step C use a book to line up metersticks at an angle of 90° to 100°. Tape the metersticks to the table top.

5. In the side vision test, the third member of each team should watch to make sure that the subject is looking straight ahead at the small jar only.

6. In Steps C and D, the tester should make sure that the subject does not see the colored object before the test is given. Switch objects between tests.

7. Assist students as necessary in calculating their average side vision and depth perception scores.

8. EXTRA. When performing the side vision test, record both the distance at which the subject saw the color and the distance at which he or she identified the object. Generally, color identification comes before object identification.

Another way to perform the test is to repeat it 3 times with each eye and calculate the average distance for recognizing the color and for recognizing the object. Record results in table form, as in this example.

	Left Eye		*Right Eye*	
	Color	*Object*	*Color*	*Object*
Test 1	50 cm	64 cm	48 cm	60 cm
Test 2	60 cm	62 cm	50 cm	64 cm
Test 3	50 cm	61 cm	52 cm	62 cm
Average	53.3 cm	62.3 cm	50 cm	62 cm

9. For the depth perception test, place a pencil to 1 side near the end of a table. Then place a small object such as a toy car to the other side at the other end of the table.

10. Subject must sit so that his eyes are level with the 2 objects and *not* above them. Using a meterstick, subject pushes the small object until he sees the front end of the object exactly even with the pencil. Note that the small object should not touch the pencil.

11. In Step F measure the distance between the front end of the car and the pencil. Results may be recorded in table form.

Depth Perception Both Eyes

	Distance Between Pencil and Car
Test 1	7.5 cm
Test 2	2.5 cm
Test 3	1.2 cm
Average	3.7 cm
Rating	Good

12. In Step G, before repeating the test, move the pencil to a different location. Average scores greater than 5 cm are poor, between 2 and 5 cm are good, less than 2 cm are excellent.

13. EXTRA. How does depth perception using both eyes compare with perception when only 1 eye is used? To demonstrate that depth perception requires both eyes, have students repeat the tests 3 times using 1 eye only. The closed eye can be covered with a blindfold or with the free hand. Results may be recorded in table form.

Depth Perception One Eye Only

	Distance Between Object and Car
Test 1	11 cm
Test 2	5 cm
Test 3	8 cm
Average	8 cm
Rating	Poor

TEACHING TIPS

1. Students may have to stare at figures g, h, i, p, and k for several minutes to see the illusion.

2. After pairs of students complete the worksheet, hold a class discussion. You may wish to have students write a *brief* description of each optical illusion.

OPTICAL ILLUSION WORKSHEET

Materials
rulers

ANSWERS TO WORKSHEET QUESTIONS

a. Both lines are the same length.
b. The distances are the same.

c. Yes. The (divergent) lines that cross lines 1 and 2.
d. Yes.
e. Yes.
f. Yes.
g. It appears to begin from the middle of the figure but this is impossible.
h. It moves back and forth between the front wall and the back wall.
i. The 2 perceptions alternate.
j. Alternately a vase and 2 faces in profile.
k. The 2 perceptions alternate.

ANSWERS TO QUESTIONS

1. The individual looks short in the picture on the left and tall in the picture on the right. In the picture on the left the room, windows, doors, and chair are oversized. In the picture on the right the room, windows, doors, height of ceiling, and chair are undersized; the man is close to the camera.
2. Answers will vary. There is considerable variation in normal side vision.
3. Answers will vary.

8 SKIN SENSE Pages (35) 291 - (38) 294

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .
a. list the principal body senses.
b. explain how blind people read.
c. measure the sensitivity of touch at different locations on the body.
d. describe how it feels to identify objects with only the sense of touch.
e. name the various skin senses.

TEACHING TIPS

Discuss additional questions with the class:
1. Based on the activity, which area of the skin is least sensitive? Explain the result.
2. List the body senses.
3. Based on the touch game, describe how it feels to identify objects with only the sense of touch.
4. Name the various skin senses.
5. For the experiment to locate the nerve endings for heat and cold, sterilize medium size nails in alcohol or boiling water. Place nails in beakers of ice water and hot water (hot water should be just hot enough to be felt on the inside of the forearm). Following the same procedure as in the Sense-Of-Touch Activity, the blindfolded subject is asked to tell whether each nail is hot or cold. Students must work quickly, as nails will return to room temperature quite rapidly.

SENSE-OF-TOUCH ACTIVITY

Materials (per pair of students)
corrugated or plain cardboard
9 clean pins
ruler
scissors
blindfold (handkerchief)

Notes on the Activity
1. Warn students about the dangers of carelessness with pins.
2. Students should cut out 5 strips of cardboard, each approximately 8 cm by 1.5 cm; then push pins about $\frac{1}{3}$ of the way through each strip, as shown in Step A. If a paper cutter is available, prepare the strips in advance.
3. In Step D caution students to apply the pin lightly to the skin without breaking through it.
4. If blindfolds are not available, subjects should just look in another direction.
5. Answers to the TABLE OF RESPONSES TO TOUCH will vary.

THE TOUCH GAME

Materials (per group of 2 or 3)
shoe box or paper bag
blindfold (If blindfolds are not available the batter should just look away. Although students should preferably use their own small objects, provide some such as chalk, index cards, rubber bands, or paper clips.)

ANSWERS TO QUESTIONS

1. The more sensitive the area of skin, the finer the discrimination between 2 points.
2. Finger tip. It has many touch nerve endings.

9 DRUG SCENE Pages (39) 295 - (42) 298

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to express his or her feelings about drug use.

TEACHING TIPS

1. Make a large paper SPEED KILLS button and pin it on Jose in SCENE C.
2. Do not try to lecture about drug abuse. Such a tactic is ineffective, since each person must arrive at his or her own set of values. In this chapter, role-playing is the vehicle used to guide students toward a healthy outlook on drugs.
3. The beginnings of 5 short playlets are indicated. Divide the class into 5 groups, and let each group choose 1 of the playlets. The group must decide how it wants the action to develop, and who will play the several roles. If they wish, the groups may add additional characters or they may change the dramatic line. There is a minimum of 19 active participants in the lesson. If you have a large class, assign the same playlet to more than 1 group. Different groups may develop quite different outcomes for the same skit.
4. Students may at first need a little coaxing to play their roles. Choose as the first players an outgoing, enthusiastic group. Assist groups that need help.
5. After each playlet has been enacted, encourage discussion of the concepts and values that came out of the presentation.
6. Ask students to interpret the figures on pages (39) 295, (40) 296, (41) 297, and (42) 298.

10 DRUGS AND THE WATER FLEA Pages (43) 299 - (46) 302

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. name 3 small crustaceans.
b. describe Daphnia.
c. perform tests to determine the effects of stimulants and depressants on heart rate in Daphnia.

TEACHING TIPS

1. Using the diagram on page (43) 299, review the structure of Daphnia.
2. Define a stimulant as a drug that speeds up certain body processes such as heartbeat and breathing rate. Define a depressant as a drug that slows down body processes.
3. In your post-activity discussion, discuss the effects that hard drugs and related substances (e.g., alcohol, cigarettes, coffee, marijuana) may have on people.

CAUTION: Maintain strict control over all drugs; students should have access only to the final dilute solutions.

WATER FLEA ACTIVITY

Materials (per pair of students)
- Daphnia culture
- microscope
- slide and cover slip
- cotton
- nylon bristles (obtain from a toothbrush or paint brush)
- eye dropper
- dropper bottle of water
- paper towels

(per class)
- 4 dropper bottles of yeast suspension (food)
- 4 dropper bottles of carmine suspension (colored water)
- 1 or 2 dropper bottles of dilute solutions of each of the following: acetylcholine, adrenalin, ethyl alcohol, tranquilizer (chlorpromazine), stimulant (amphetamine), nicotine; of several of the following: calcium carbonate, sodium carbonate, sodium chloride, tea, coffee
- clock with second hand

PREPARATION OF MATERIALS

1. Daphnia may be obtained from a pond, tropical fish store, or biological supply house.

This activity can also be performed with Tubifex worms which may be obtained from tropical fish stores.

2. Acetylcholine may be purchased already diluted 10,000 to 1. If concentrated, dilute the drug by adding 1 drop to 700 ml of water.

3. Prepare adrenalin in the same manner as acetylcholine.

4. To prepare a dilute (1%) solution of alcohol, add 1 ml ethyl alcohol to 99 ml of water.

5. Ask a doctor for small quantity prescriptions of samples of reserpine, chlorpromazine, or other tranquilizer, and dextrine, amphetamine sulfate, or other stimulant. These drugs come in either 5 mg or 25 mg tablets. Crush the tablets and suspend in 25 ml of water for each 5 mg. Filter the preparation or allow it to settle for about an hour. Decant and use the clear liquid.

6. Prepare a nicotine solution by soaking a nonfilter cigarette in 100 ml of water for an hour. Filter the extract before using it.

7. To prepare additional test chemicals, use solutions of the following concentrations:

0.5% (0.5 g per 100 ml of water) calcium carbonate or sodium carbonate
0.9% sodium chloride
weak tea or weak coffee

8. Drugs may be obtained from a pharmacy or biological supply house.

9. If the chemical solutions are so concentrated as to kill the Daphnia, dilute the solutions further.

10. To prepare food, dissolve a package of dry yeast in warm water.

11. To prepare colored water, add a small pinch of carmine to water.

Notes on the Activity

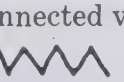
1. To review the use of the microscope, see "Action Biology," *The Invisible World*, Chapters 1 and 2.

2. Demonstrate Step A, the preparation of a Daphnia slide. Show students how to: use a dropper to place Daphnia on a slide; remove excess water with paper towelling; trap Daphnia in cotton fibers; support the cover slip with nylon bristles.

3. In this activity, use the low power objective. To see Daphnia better, reduce the amount of light. In Step B warn students to use gentle pressure on the cover slip.

4. In Step D assist students in adjusting the diaphragm.

5. In Steps E and F demonstrate how to add food and colored water to the slide.

6. For Step G check to make sure students do not mistake the beating of the gills for the heartbeat. To obtain the heart rate, tap with a pencil on paper in rhythm with the heartbeat and then count the resulting dots. Or, make a series of connected vertical pencil marks, like this  , in time with the rhythm of the heart. Have students practice taking the normal heart rate before administering any drugs. To obtain a more accurate heart rate, have students repeat Step G 3 times and average the results.

7. Demonstrate Step H. Add 1 or 2 drops of a drug at the edge of the cover slip; then, as shown in Step E, use paper towelling to pull the drops under the cover slip. After counting the heart rate, thoroughly flush each drug from under the cover slip with *several* drops of water.

8. Students must be careful not to contaminate droppers with drugs.

9. Students often expect drugs to produce dramatic changes in the heart rate. This is not usually the case: an increase or decrease of 10% is significant. The table shows rates to be expected.

Effect of Drugs on Water Flea Heart

Drug	*Heart Rate per Minute*	*Stimulant or Depressant*
none	240	—
amphetamine	270	stimulant
chlorpromazine	190	depressant
coffee	280	stimulant
adrenalin	300	stimulant
nicotine	296	stimulant
alcohol	210	depressant

10. At the conclusion of the activity "used" Daphnia should be transferred into a new culture jar. After a reasonable period of time they can be used by another class.

11. If Daphnia are not available, substitute Tubifex worms. Prepare slides in the same manner. To demonstrate the effect of drugs, observe the pulsating contractions of the dorsal blood vessel or the small heart in the anterior end.

ANSWERS TO QUESTIONS

1. The water flea is a small crustacean. The shell almost completely covers the animal. The shell and the animal as a whole are sufficiently transparent so that the internal organs can be seen. Externally it has 1 eye, feelers and legs.

2. There are 2 long feelers, or antennae. Daphnia swims by means of them. The shorter feelers, or antennules, are sensory.

3. The eye of the water flea rotates. Changing the brightness of the light changes both the speed and the direction of rotation.

4. The beating of the legs passes food to the

4 mouth parts which crush the food and manipulate it into the mouth.

5. The 5 pairs of legs are located under the shell; they beat continuously. The resulting water currents bring oxygen to the gills.

6. Answers will vary. Depending on temperature, the range is between 180 and 350 beats per minute.

7. Stimulants: amphetamine, coffee, adrenalin, nicotine, tea.

8. Depressants: chlorpromazine, tranquilizers in general, alcohol.

11 BANANAS AND CARD GAMES Pages (47) 303 - (50) 306

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe some situations demonstrating that animals may possess the ability to think.

b. describe the parts of the brain that control the main body functions.

c. tell the significance of brain waves.

d. give examples of insight, and deductive and inductive reasoning.

e. describe the reasoning processes used in the Guess-The-Pattern Game.

TEACHING TIPS

1. Since many students have dogs, ask the dog owners to comment on the statement in Section A that dogs do not think well. Ask for other possible examples of thinking animals. Evaluate suggestions.

2. Have students explain the significance of the figures on page (47) 303, (48) 304, and (49) 305.

3. Before playing the card game, go over the inductive, deductive, and insight thought processes as described on page (49) 305. Ask students to give examples of each type of thinking.

Deductive reasoning is the process of moving logically from the general or universal to the particular, or from a given premise to a conclusion. Inductive reasoning is the process of moving from the particular to the general, or of arriving at a generalization on the basis of many examples. This is the basic method used in natural science. Insight is the little-understood process by which intuitively and at 1 stroke a solution to a problem is perceived.

4. A regular deck of playing cards is needed for each pair of students. Ask students to provide their own decks. Stress that after each game the students should describe the kind of reasoning they used to solve the card pattern. Assist students in doing this.

ANSWERS TO QUESTIONS

1. Answers will vary. For example, applied a rule and checked it; looked at examples and made a rule; I was guessing and all of a sudden it came to me.

2. Reasoning is used both by the chimpanzee trying to get the bananas, and by the human playing a card game.

12 HOW WE LEARN Pages (51) 307 - (54) 310

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe some of the things people learn to do in and out of school.

b. describe Pavlov's conditioning experiment with dogs.

c. give examples of human responses which have been conditioned.

d. give examples of trial and error learning.

e. perform a simple learning experiment and graph the results.

f. demonstrate that practice improves learning.

g. demonstrate that it is easier to learn meaningful things than non-meaningful things.

BRAIN-TEASER ACTIVITY— THE MATCH PUZZLE

Materials (per pair of students)

8 burnt tip matches or half Q-Tips
clock
graph paper

Notes on the Activity

1. Go over the directions for the puzzle. Show students how to place the 8 matches as in the

first arrangement in Step A. Show that 2 neighboring matches must be moved at the same time. Point out the final arrangement. If a subject gets confused during a trial and desires a fresh start, consider this a 4 minute trial. No trial may take longer than 4 minutes.

2. Ask students who solve the puzzle not to reveal the solution prematurely to others in the class.

3. After a suitable period of frustration—5 to 15 minutes—briefly interrupt the class and ask them to describe the learning method they are using to solve the puzzle. They will probably say trial and error. Then tell the class that the puzzle can be solved in 4 moves and that from time to time you are going to place the correct moves on the chalkboard. After placing the first move on the board, give the remaining moves at reasonable time intervals:

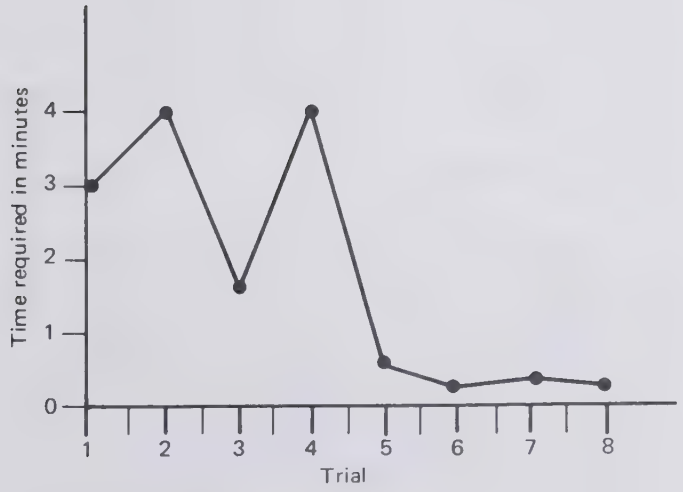
Move 2 and 3 to 9 and 10;
5 and 6 to 2 and 3;
8 and 9 to 5 and 6;
1 and 2 to 8 and 9.

4. Sample MATCH PUZZLE chart.

Trial No.	*Time Required*
1	3 minutes
2	4 minutes—subject confused
3	1 minute 20 seconds
4	4 minutes—subject confused
5	35 seconds
6	15 seconds
7	20 seconds
8	15 seconds

5. Assist students by showing them how to make a line graph of the results.

6. Sample learning curve graph.



7. At the conclusion of the activity have students draw their learning curve graphs on the chalkboard and discuss the graphs. Ask students to show on their graph where each of the following may have occurred: trial and error learning, plateau (leveling off) learning, insight, accidental learning, frustration in learning, and increased speed of learning through practice.

The word lists can be used by students individually or by the class as a whole. In either case, place individual results on the board and discuss.

ANSWERS TO QUESTIONS

1. Answers will vary.

2. Pavlov rang a bell each time he gave food to the dog. Soon the bell alone made the dog's saliva flow.

3. I am conditioned to getting dressed as soon as I get out of bed because I have been doing this for so long. I follow my schedule in school without thinking about it; leaving 1 class is the stimulus to go to the next. I automatically say "Thank you" when someone gives me something because I have been conditioned by general approval for doing so. Many other examples may be given.

4. Because you keep on trying different keys until you find the right one.

5. My learning curve told me that first I was using trial and error to solve the problem; practice improved my performance; once I had figured out how to do the puzzle, I could do it much faster; finally I reached a plateau where additional practice did not improve my performance.

6. At first I used trial and error to try to solve the match puzzle. When the teacher put the moves on the board, I imitated them. Because I was interested and motivated, I then learned the moves very quickly.

7. Remembered fewest words; but answers may vary.

8. Remembered some words; but answers may vary.

9. Remembered all or almost all of the words.

10. On the first list I had the lowest score because the list was made up of unfamiliar, nonsense words. On the second list I had a better score, even though the words were not in order, because the words were familiar and meaningful. The third list was a sentence which had meaning, and I made the highest score on it.

13 ESP Pages (55) 311 - (58) 314

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. define extrasensory perception.
b. tell how a bat uses its sense of hearing to avoid obstacles.
c. describe the migration of the Arctic tern.
d. test for ESP by using a deck of playing cards.
e. summarize the results of the ESP activity.
f. devise a mind reading experiment.

TEACHING TIPS

1. Have students write their names and their total scores on the chalkboard. Base the discussion of the activity on these recorded results.
2. Better-than-chance scores have been held to show ESP. Similarly, poorer-than-chance scores have been held to show negative ESP. Gamblers who always lose may have negative ESP.
3. Of course, conclusions of this kind are subject to criticism on statistical grounds. Results from a few isolated trials are quite meaningless. Both a large number of trials and statistical evaluation of the results are needed in order to support the validity of any conclusions. During the discussion, in simple language, point out these considerations to the students.

ESP ACTIVITY

Materials (per pair of students)
deck of playing cards (Ask students to provide their own decks.)
duplicated copies of TABLE OF GUESSES AND ACTUAL CARDS (blackline master #9)

Notes on the Activity
1. Go over the activity and distribute copies of the table. Show students how to use the suit key to record guesses and actual calls and to circle the correct guesses on the table.
2. In 1 test, by pure chance, you can expect 5 correct guesses out of every 20 tries.

ANSWERS TO QUESTIONS

1. Answers will vary.
2. Yes or no, with supporting reasons.
3. Yes. Tester should concentrate on each card and record its suit. Subject has his back to the tester and records his guess. At the end of a trial, compare tester's and subject's records.

14 FACES, FACES Pages (59) 315 - (62) 318

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. identify the emotions and expressions shown in facial expressions.
b. distinguish between body language and face language.
c. explain why it is helpful to release emotions.
d. describe how facial expressions are made.
e. use makeup to create an expression, then act out the appropriate emotion.
f. draw facial expressions.

TEACHING TIPS

1. This chapter is based on psychological studies of the emotional basis of facial expressions.
2. Ask students to describe the emotions expressed by the characters in the cartoon on page (59) 315. Have students describe situations in real life or from television in which body language and facial expressions communicate emotions. Why is it bad to keep emotions in?
3. Discuss some of the ways psychologists help people.
4. Use the picture of Mary Tyler Moore, or pictures of other actors or actresses, to discuss how they use makeup for their roles.

MAKING-FACES ACTIVITY

Materials

mirror	scissors
eyebrow pencils	pencils
soap	crayons
paper towels	paste
newspapers and magazines	tape or thumb tacks

Notes on the Activity

1. Divide the class among parts A, B, and C of the activity. After completing 1 part students may switch to another.
2. Students who do A should demonstrate and explain to the class how they make their facial expressions.
3. In part B small groups of students should create roles with different emotions, then in brief playlets act out the roles for the class. Although additional makeup may be used, an eyebrow pencil is really all that is needed to create facial expressions. Use the figures on page (61) 317 to help draw the proper facial lines for the roles.
4. In part C, mounting of pictures is optional. The drawings on page (61) 317 can be used as a guide to facial expressions. Give students an opportunity to describe how they changed the pictures.

FACES WORKSHEET

The worksheet must be done before the activity. Students can do the worksheet singly or in small groups. In the class discussion, accept differences in opinion as to which word best describes the facial expressions; some faces may be described by more than 1 word. Following is 1 interpretation.

Face	*Expression*	*Face*	*Expression*
a	thoughtful	h	criminal
b	grief stricken	i	frightened
c	surprised	j	kind
d	evil	k	angry
e	sad	l	enraged
f	relaxed	m	in pain
g	smiling		

ANSWERS TO QUESTIONS

1. Answers will vary.
2. Answers will vary.

15 MOONWALK* Pages (63) 319 - (64) 320

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. identify forms of interaction within a small group.

b. describe some problems involved in working in a small group.

LOST-ON-THE-MOON* ACTIVITY

Notes on the Activity

1. Chapter 15 is a group dynamics activity. The student text is designedly cryptic so as not to reveal the true purpose of the lesson.
2. Choose 4 to 6 volunteers to form the team of spacemen. While the volunteers wait outside the classroom, read aloud or distribute the following statement. The publishers grant permission to reproduce the statement within quotation marks.

"When the volunteers return to the room, they will promptly tackle the LOST-ON-THE-MOON WORKSHEET. They will not realize that the worksheet is an excuse; today's lesson is not at all concerned with it. Rather, the lesson is concerned with how a group of students interact with each other in dealing with a problem.

A group of people *always* interact with each other—whether they be a mob, a family, a club, a couple on a date, a group of friends, a neighborhood, a work gang, or a whole community.

Watch the students as they deal with their problem. Observe the kinds of interaction that quickly develop. Here are some things to look for:

a. Does a leader appear? Is leadership permanent, or shifting?

b. Are members of the group cooperative or competitive?

c. Do they focus on the problem, or on side issues and personalities?

d. Does the discussion involve reason and logic, or just opinions?

e. Do they work as 1 group, or do they split into factions? Give examples of good as well as poor team work.

*LOST-ON-THE-MOON was developed by Jay Hall. Copyrighted 1963, Teleometrics International, Conroe, Texas 77301. May not be reproduced without permission.

f. Are members honest with each other, or reluctant to say anything?

g. What is the "tone" of the group—tense or relaxed; interested or uninterested; serious or not serious; full of life or lifeless; positive or negative? Is there a unified tone?

h. Is the group list more accurate than individual lists? Why?

i. There are many other areas of group interaction that can be observed, even in a few minutes.

Please do not talk while the volunteers are in action. Observe their actions. Take notes if you wish. Save your conversation until *after* the group has been let in on the secret."

3. Have the volunteers return. Read the worksheet to the class. Give the volunteers copies of the List of Available Items, and pencils, if necessary. Individually, without consulting, they are to number the items as indicated. Then orally the volunteers are to agree on a group list. Give no other directions.

4. Record on the board the group's numbering of the list, but do not say anything, or interfere in any manner in the discussion.

5. After the volunteers have agreed on a group list, let them in on the secret: that this is really a lesson about interactions in a group —group dynamics—not a lesson about astronauts on the moon.

6. Lead the discussion by going over the questions that were given to the class. Also encourage free discussion that strays from the list of questions.

7. Listed below are the suggested rankings for the LOST-ON-THE-MOON WORKSHEET. Rankings, and the reasons for them, were provided by NASA's Space Survival Unit.

1—Tanks of oxygen	Fills respiration requirement
2—Can of water	Replenishes perspiration and other water losses
3—Star map	One of the chief means of finding directions
4—Concentrated food	Supplies daily food requirement
5—Radio receiver and transmitter	Distress signal transmitter; possible communication with ship
6—Nylon rope	Useful in tying injured; help in climbing
7—First-aid kit	For treatment of injuries or illness
8—Inflatable life raft	Use bottles of gas for self-propulsion across chasms
9—Signal flares	For distress calls within line of sight
10—Loaded pistols	Self-propulsion devices could be made from them
11—Solar powered heater	Little or no use on the moon
12—Box of matches	Little or no use on the moon

SUPPLIES AND EQUIPMENT

Large Equipment

Aquarium
Clock
Lamps, microscope
Microscopes, compound
Microscopes, dissecting

Small Equipment

Battery jar
Beakers, medium
Compass, drawing (optional)
Cover slips
Dissecting needles
Dropper bottles
Droppers
Fish net
Forceps
Glass plates
Hand lenses
Petri dishes
Pins, dissecting
Rulers
Scalpels
Scissors
Slides, microscope
Test tubes, small
Trays, dissecting
Tongue depressors
Yardsticks or metersticks

Chemicals

Acetylcholine
Adrenalin
Alcohol, ethyl
Alcohol, isopropyl
Ammonia
Amphetamine
Calcium carbonate (optional)
Calcium chloride
Carmine
Chlorpromazine
Potassium chloride
Sodium bicarbonate
Sodium carbonate (optional)
Sodium chloride

Biological Materials

Daphnia (live)
Frogs (live)
Frogs (preserved, optional)
Mealworms (live)
Snails (live)
Yeast, package or cake

Consumables Obtainable Locally

Aluminum foil
Cardboard
Cereals (oatmeal, bran, etc.)
Coffee, instant
Construction paper, assorted colors
Cotton
Crayons
Eyebrow pencils
Fruits, fresh assorted
Graph paper
Lettuce
Matches, wooden
Nails
Newspapers and magazines
Nylon paint brush
Orange peel
Paper bags, large

Paper, heavy
Paper towels
Paste or glue
Pencils
Pins
Plastic sheet, clear
Playing cards, decks of
Q-Tips
Sandpaper (optional)
Soap
Soda straws
Tape, cellophane
Tape, masking
Tea
Toothpicks
Toy car (optional)
Vegetables, fresh assorted
Vinegar

AUDIOVISUAL MATERIALS

For meaning of abbreviations, see *Teacher's Guide,* page 131.

Adaptive Radiation: The Mollusks. Color or B&W, 18 min., EBE. (Adaptations and classification of mollusks from the evolutionary point of view.)

Animal Communications. Filmstrip, Popular Science.

Animal Navigation. Filmstrip, Popular Science.

Behavior. Color or B&W, 28 min., MGH. (Instinctive and learned behavior.)

Behavior in Animals and Plants. Color or B&W, 11 min., Coronet. (Tropism, reflex action instinct, and intelligence-based reasoning are demonstrated.)

Blind As a Bat. Color or B&W, 7 min., Moody. (Discusses echo location.)

Crustaceans (Lobsters, Barnacles, Shrimp, and Their Relatives). Color or B&W, 14 min., EBE. (Survey showing the importance of this group to man and to the balance of nature.)

Drug Abuse. Filmstrip Series, EBE.

Drug Addiction. B&W, 22 min., EBE. (Depicts various drug problems as they relate to teenagers.)

The Drug Dilemma: A New Day Dawning? Color or B&W, 27 min., Coronet.

Drug Misuse and Your Health. Sound Filmstrip, Society for Visual Education.

Drugs and the Nervous System. Color, 16 min., Churchill.

Exploring the Human Nervous System. Color, 23 min., Churchill. (Discusses reflexes, brain centers, and research in memory.)

Frog Anatomy. Color or B&W, 16 min., Indiana Univ. (Shows detailed dissection of a frog.)

Frogs and Toads. Color or B&W, 12 min., MGH. (Frog life cycle, and functions of various amphibians.)

Frontiers of the Mind. B&W, 25 min., EBE. (Shows the use of drugs, and electrode implantation in brain research.)

Fundamentals of the Nervous System. Color or B&W, 17 min., EBE. (Descriptive; structure and function of the major divisions.)

Gull: Courtship and Territoriality. Film Loop, BFA.

The High: Drugs and You. Color or B&W, 19 min., Coronet.

Hooked. B&W, 20 min., Churchill.

The Human Body: The Brain. Color, 16 min., Coronet. (Excellent.)

The Human Body: Nervous System. Color, 14 min., Coronet. (Emphasizes functions.)

Introducing Insects. Color or B&W, 17 min., National Film Board of Canada and EBE. (Characteristics of insects in general and the main orders of insects.)

The Invertebrates. Color or B&W, 14 min., Coronet. (General survey of this division of the animal kingdom.)

Investigating Territorial Behavior. Film Loop, BFA.

The Jointed-Legged Animals: Arthropods. Color or B&W, 19 min., EBE. (Structure and functions, characteristics, and classification of the group.)

Larva, Crawling and Eating. Film Loop, EBE.

The Living Mammal. Color, 17 min., International Film Bureau. (Defines mammals, and shows various mammalian adaptations.)

Monkeys and Apes: An Introduction to the Primates. Color or B&W, 10 min., Film Associates of California. (Brief presentation of the principal primate groups.)

Nerve Action—The Reflex Arc. Film Loop, EBE.

The Nervous System. B&W, 11 min., EBE. (Structure and function of central nervous system.)

The Nervous System. Filmstrip, Popular Science.

Physiology of Behavior. Filmstrip Series, Popular Science.

Sense Perception. Part I: The Wonder of the Senses. Color, 27 min., Moody. (Thorough study of sense receptors and perception.)

Sense Perception. Part II: The Limitations of the Senses. Color, 27 min., Moody. (Stresses limitations of sight and hearing.)

The Senses. Color or B&W, 28 min., MGH-AIBS Series. (Discusses vision, nerve impulses, hearing, and taste.)

Scag. Color, 21 min., EBE. (About heroin.)

Visual Perception. Color, 19 min., Horizons of Science and Educational Testing Service. (Discusses experimentation in the field of perception.)

Ups/Downs. Color, 24 min., EBE. (About amphetamines and barbiturates.)

Weed. Color, 24 min., EBE. (About marijuana.)

CHILDREN and ANCESTORS

CONTENTS

PLAN AHEAD for the following lessons:

Chapter 1 Assemble the containers and objects.
3 Order and set up slime mold cultures.
5 Obtain or make chips and prepare envelops for moth activity.
7 Obtain PTC paper. Duplicate copies of HUMAN GENETICS WORKSHEET.
10 Obtain or make chips and containers.
11 Obtain blood typing anti-sera and sterile lancets.
12 Obtain smooth and wrinkled peas, and glucose-1-phosphate. Prepare mashes and sugar-agar Petri dishes.
15 Collect materials for DNA models.

1 FOSSILS AND OIL WELLS Pages (3) 323 - (8) 328

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. make a "fossil replica" in plaster.
b. tell what a fossil is.

c. compare a reconstructed fossil and an actual organism.
d. interpret a fossil table and identify the rock layers from which particular fossils come.
e. tell how microfossils are used in oil prospecting.
f. describe job opportunities in the oil industry.

TEACHING TIPS

1. The theme of this chapter is that fossils accurately tell us of the history of life on earth.
2. The fossil lobe-fin discussed in Section C is the coelacanth.
3. In Section D simple synonyms are used for the scientific names of geological eras, as follows:

Geological Era	*Synonym*
Cenozoic	Recent layers
Mesozoic	Middle layers
Paleozoic	Old layers
Precambrian	Ancient layers

4. In discussing vocational opportunities in Section E, ask the students what jobs they would be most interested in, and how they could prepare for these jobs.
5. Ask students to relate the Making-A-Fossil Activity to the 3 pictures in the middle of page (6) 326. These pictures show digging out a fossil, chipping a fossil out of rock, and reconstructing a fossil.

MAKING-A-FOSSIL ACTIVITY

Materials (per student or pair of students)
2 disposable containers or heavy duty aluminum foil
scissors to cut aluminum foil
plaster of Paris
plastic spoons
Vaseline
small artist brush or Q-Tip
shell or other biological specimen
hammer
screwdriver
large heavy cloth

Preparation of Materials
Obtain 2.5 kg of plaster of Paris from a paint or hardware store. To mix, follow the directions on the package.

Notes on the Activity
1. Don't throw plaster of Paris down the sink drain. It will harden and clog up the drain. Water should run continuously when washing plaster covered equipment in the sink. *Do not* mix plaster in a container that you want to keep. If the plaster hardens, you may not be able to clean it easily.
2. If you have never worked before with plaster of Paris, experiment with some until you get the right consistency and a feel for its setting (hardening) time.
3. For Steps A, D, and G mix plaster in disposable containers such as cans, cottage cheese containers, cut down milk cartons, plastic dishes, aluminum pans, cut down bleach bottles, or in boats made from heavy duty aluminum foil. For the dish in Steps A through D use heavy duty aluminum foil boats or a disposable container.
4. For Steps B and D mix plaster to the consistency of putty so that it will harden quickly.
5. Plaster sets fast. Mix only what you need right before you need it. Therefore, mix a new batch of plaster each time for Steps A, D, and G.
6. Each group can mix their own plaster. Alternatively, you may want to mix it yourself for the class or assign students to do the mixing.
7. Students tend to want to make overly large molds. Since both molds and objects are small, ration the amount of plaster used.
8. For Step B almost any small biological specimen can be used, such as twigs, chicken bones, acorns, fruit pits, orange or grapefruit seeds, dry beans, etc.
9. In Steps C and D thin layers of Vaseline should be applied with a small brush or Q-Tip.
10. In Step E molds should break open easily. If not, use a hammer and screwdriver. Take proper eye precautions by covering the mold with a cloth before striking it.
11. For Step G the plaster should be the consistency of thick batter.
12. Fossil handprints and footprints can also be simulated in the plaster.

ANSWERS TO QUESTIONS

1. Yes. There is a close resemblance, except that in the present day lobe-fin the fins are not spread out.
2. The recent layers.
3. The middle layers.
4. If the right microfossils are found, the drilling continues. If the prospector doesn't find them, the drilling stops.
5. A fossil is the remains or record of an ancient living thing. Dinosaurs are animals that we know only from fossils. Roughnecks are people who work in oilfields.

2 CHANGING HORSES Pages (9) 329 - (12) 332

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. list uses of horses and jobs with horses.
b. recognize various breeds of horses.
c. tell the story of eohippus and its descendants.
d. decide if eohippus changed, and give supporting evidence.
e. define evolution.

TEACHING TIPS

1. Chapters 2 through 5 deal with evolution. These chapters should be taught together, though not necessarily in order or completely. Changing Horses uses the history of the horse to develop the basic concept of evolution.
2. Sections A and B discuss the role of the horse in modern life. If your students have had any contact with horses, ask the students to relate these experiences. Ask how various breeds of horses differ, and how they serve different purposes.
3. Develop the evolution of the horse by discussing questions 3 through 12 while the students examine the FOSSIL HORSES TABLE. Use questions 12 and 13 to summarize the changes that have taken place.
4. Common synonyms for animals in the horse genealogy have been used in place of scientific names, as follows:

Scientific name	*Common synonym*
Hyracotherium	eohippus
Mesohippus	3-toed leaf eater
Merychippus	3-toed grass eater
Equus	horse

Numerous side branches have been left out, and there is no implication in the table that the line of evolution was direct from eohippus to the horse.

5. Students can best summarize the chapter by orally answering question 15.

ANSWERS TO QUESTIONS

1. Answers will vary.
2. Answers will vary.
3. Three-toed grass eater and horse.
4. On grassy prairies.
5. They could run easily on the hard, open land.
6. Eohippus lived in the forest.
7. Eohippus had 4 toes on each forefoot and no hooves. The horse had 1 toe with a hoof. Student may also draw a picture.
8. The 3 toes could spread on the soft forest ground as it was running.
9. The big middle toe had a hoof. It was good for running on the prairie.
10. Eohippus had shorter teeth.
11. Its teeth were in between in length.
12. Eohippus could walk on the soft forest ground, and its teeth could chew leaves.
13. The horse could run on the hard, open ground. It could chew tough grass. It was big enough to kick and fight.
14. Answers will vary. Probably eohippus and its descendants slowly changed.
15. Slow change from 1 kind of animal or living thing into a different kind.

3 EVOLUTION Pages (13) 333 - (16) 336

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe the family tree of dogs in general terms.
b. recognize that all animals are related.
c. recognize that all plants are related.
d. recognize that all life probably evolved from plant-animal ancestors.
e. state an opinion concerning evolution or separate creation.

TEACHING TIPS

1. This chapter is similar to Chapter 2 in teaching the basic notion of evolution. However, it brings in the whole panorama of life instead of focusing narrowly on the horse.
2. Ask students which animals on the dog family tree they are familiar with. Discuss student experiences with dogs. Elicit the idea that the various types of dogs were produced by breeding, and that all dogs are related. Discuss dog-wolf interbreeding. What other animals are dogs related to? Ask students to interpret the family tree on page (13) 333.
3. Using the figures in Sections B and C, discuss relationships among animals and among plants.
4. Slime molds are plant-animals and might be close to the hypothetical common ancestors of plants and animals.
5. Note that the chapter does not enter into the question of the ultimate origin of all life. If this question arises, allow free discussion without asserting any authoritative answer.
6. Section D introduces separate creation as an alternative to evolution. While biologists generally reject this alternative, stress that students are free to form their own opinions. Point out that when doing so, it might be well to consider available evidence.

SLIME MOLD ACTIVITY

Materials (per group of 2 to 4)
- Petri dish with slime mold
- crumbled flakes of oatmeal
- dropper bottle of vinegar or dilute acid
- marker
- dissecting needle
- magnifier (optional)
- compound microscope (optional)
- slide (optional)
- dropper (optional)
- water (optional)

(per class)
- dissecting binocular microscopes

Preparation of Materials
A slime mold culture (Physarum) will arrive, with instructions from the supplier, in the form of a dried plasmodium. Three days ahead, set up a number of Petri dishes lined with wet filter paper and transfer the slime mold to these dishes. Place several crumbled flakes of uncooked rolled oatmeal (not instant) into each dish. Store the dishes in the dark in a closed vessel containing a dish of water to maintain a humid atmosphere, or seal the Petri dishes with masking tape. The slime molds will spread over the oats, and grow. Discard dishes which become overgrown with bread mold or other fungi. Cut up the pieces of filter paper which have healthy growths, and distribute them in fresh Petri dishes for handing out to students.

Notes on the Activity
1. For Step B examine the slime mold with a dissecting binocular microscope. Alternatively, by lifting a piece of the plasmodium with 2 dissecting needles and placing it in a drop of water on a slide, students can examine the plasmodium under low power with a compound microscope, without a cover slip.
2. Instructions on the use of the microscope are found in "Action Biology," *The Invisible World*, Chapters 1 and 2.
3. Steps C, D, and E can be observed with the naked eye, a magnifier, or under a microscope.
4. In Steps F and G, to induce the ameboid plasmodium stage to change into the spore-forming fruiting stage, place the closed Petri dishes in the light and allow the moisture to evaporate slowly. It may take several days for the fruiting stage to appear.

ANSWERS TO QUESTIONS

1. Birds.
2. Simple animals.
3. It's a yellowish, speckled jelly. It moves by flowing slowly.
4. It flows away from the needle.
5. It flows away.
6. It flows over the oatmeal.
7. It eats food. It reacts to a probe and to acid.
8. It has an indefinite shape. It doesn't have the organs of an animal.
9. Answers will vary. Any honest response, or no response is acceptable.

4 VARIATION Pages (17) 337 - (20) 340

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. interpret a graph by reading the range, average, maximum, and minimum values on a curve of normal variation.

b. determine reaction time in a simple experiment, summarize and graph the results.

c. form a considered opinion concerning grading on a curve.

TEACHING TIPS

1. Variation, an important concept in evolution, is difficult for youngsters to grasp. In developing the concept, follow the sequence of ideas in the chapter:
   a. In going over the cartoons with the students, stress Darwin's qualitative recognition that differences exist within species.
   b. In Section A use questions 1 through 5 to help students read a normal curve as a quantitative expression of variation. This curve is based on counting the number of peas in each of a large number of pods.
   c. After doing the Reaction-Time Activity, help students make their own graph of variation.
   d. In Section B use question 11 to discuss application of the variation concept to the vital subject of student grades.
2. Additional measurements of variation can be made by collecting data on length of index finger, pulse rate, length of foot, length of leaves collected from a tree, or any other biological dimensions.

REACTION-TIME ACTIVITY

Material (per pair of students)
meterstick

Notes on the Activity

1. Although this is called a Reaction-Time Activity, what is actually measured is reaction distance, which is proportional to reaction time.
2. In Step B the ruler should be suspended with the zero end opposite the subject's thumb.
3. Students will need help with Steps F and H.

ANSWERS TO QUESTIONS

1. Bell shaped. Like an upside down V. It rises evenly to a peak and then falls evenly.
2. Six.
3. Two and 10.
4. Two to 10.
5. The number of pods to the number of peas in pod.
6. Bell shaped. The same as the graph for the number of peas in pods.
7. Approximately 18 cm, but averages may vary.
8. Answers will vary.
9. Answers will vary. A probable range is 30 to 5 cm.
10. The lowest mark stands for the fastest reaction time, the highest mark stands for the slowest.
11. Answers will vary.

5 THE MOTHS OF ENGLAND Pages (21) 341 - (22) 342

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. tell the story of Kettlewell's peppered moths.
b. perform a demonstration simulating natural selection.
c. use the example of peppered moths to illustrate natural selection.
d. explain natural selection in the evolution of eohippus into the horse.

TEACHING TIPS

1. Of the 3 main component ideas of the Theory of Evolution, this chapter deals with natural selection. Chapter 4 deals with variation, and Chapter 5 with mutation.
2. In Section B discuss questions 3 through 5 with the class. In answering the questions, encourage students to draw both on the text and on their experience in the simulated experiment of the Moth Activity.
3. Question 6 is the key idea in Section C and in the chapter. In discussing the question, bring out the idea that eohippus and its descendants showed variation, and that natural selection must have worked on the variant forms just as it worked on peppered moths.

MOTH ACTIVITY

Materials (per pair of students)
envelope (23 cm $\times$ 30 cm)

20 light colored or colorless plastic chips or paper squares
20 dark colored plastic chips or paper squares

Notes on the Activity

1. Purchase poker chips, or cut small square chips from pieces of clear and colored celluloid, acetate, or mylar (available from most art supply stores). Alternatively, cut small square chips from paper the same color as the envolopes and dark colored paper. All chips should be the same size and shape.

2. In Step B it is important that the student select the first "moth" that he sees.

3. The brief experiment may be repeated several times in order to base the result on larger numbers.

ANSWERS TO QUESTIONS

1. More dark moths or chips.
2. We saw them better.
3. The light moths.
4. The dark moths.
5. There were more dark moths and they produced more dark offspring.
6. Eohippus showed variations. Some variations fitted the conditions better and they survived and had offspring. The same thing kept on happening in the descendants of eohippus.
7. Answers will vary.

6 THE LUCKY DRAGON Pages (23) 343 - (26) 346

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. tell the story of the Lucky Dragon.
b. list several types of radiation and tell how radiation may affect cells.
c. define and illustrate mutations.
d. compare artificial selection in Ancon (short-legged) sheep with natural selection in bighorns.
e. summarize how variation, selection, and mutation all contribute to evolution.
f. state and support an opinion concerning a nuclear ban.

TEACHING TIPS

1. This chapter may be used to summarize several lessons on evolution by discussing question 2, for example. Or, the chapter may be taught with the emphasis mainly on mutations.
2. Students will have some vague familiarity with nuclear bombs and radiation. Use the story of the Lucky Dragon as motivation. Then ask in what ways radiation affects us.

BOMB-TEST ACTIVITY

As called for in Step B, set up a formal hearing. Let students join the Ban the Bomb and Test Committee, the Committee for Bomb Testing, or the Congressional committee. Give each group a short time to elect a spokesperson or chairperson and prepare their position. Then, within the format of the hearing, encourage free and open discussion. At the conclusion of the hearing the Congressional committee or the class as a whole should vote on the issue, or the discussion may be left open-ended.

ANSWERS TO QUESTIONS

1. They couldn't run fast. They couldn't escape their enemies.
2. The sheep's ancestors had mutations. The sheep varied in their running and climbing ability. The best survived and had the most offspring. Thus, natural selection made the sheep change to the present bighorn types.

7 WHAT DO WE INHERIT? Pages (27) 347 - (28) 348

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. recognize human genetic features.
b. conduct a human genetic survey.
c. evaluate current ideas on inheritance.

TEACHING TIPS

1. Students will have fun examining themselves and others for the genetic traits that are illustrated.

2. Distribute copies of the HUMAN GENETICS WORKSHEET (blackline master #10) to the class.

3. As you go over the HUMAN GENETICS WORKSHEET students should check in their notes the appropriate "you" column for the features they possess.

4. When students use the HUMAN GENETICS WORKSHEET to conduct a family survey, collect the reports and carefully examine them in private before permitting a class discussion. Such a survey may reveal family relationships which the student is not aware of, or which may prove embarrassing.

5. Discuss the SELF TEST after students have completed and checked it.

Materials
PTC paper

Preparation of Materials
Obtain PTC (phenylthiocarbamide) paper from biological supply houses. You can make your own by dissolving 0.5 g phenylthiocarbamide (or phenylthiourea) in 1 liter of water. This will take about 24 hours. To dissolve PTC more rapidly, boil the solution. Soak filter paper or paper towels in the solution. After the paper dries, cut it into small pieces.

ANSWERS TO QUESTIONS

1. Answers will vary. Generally, bitter, salty, sweet, or sour. To others it is tasteless.

8 THE COLOR OF YOUR SKIN Pages (29) 349 - (32) 352

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. reconsider opinions and prejudices concerning color and race.

b. explain how color is formed in the skin.

c. describe the effect of sunlight on different racial groups.

d. state some important resemblances among different racial groups.

e. complete the RACE AND COLOR WORKSHEET.

TEACHING TIPS

1. Didactic questions have been omitted from this chapter in order to avoid any emphasis on simple accumulation of facts. The aim of the lesson is to induce students to confront and evaluate racial stereotypes.

2. Invite comment and discussion on the picture at the bottom of page (29) 349.

3. The pictures on the RACE AND COLOR WORKSHEET dramatize the difficulty in determining infallibly the national and racial origin of a person solely by appearance. Very rarely will a student correctly identify all the pictures. Have students report their results to the class, and emphasize the meaning of the results. The key to the WORKSHEET is given on page (36) 356.

4. The true-false statements on the WORKSHEET may provoke hot discussion when students check their responses. Postpone checking or discussing the responses until students have read the rest of the chapter and have re-evaluated their responses.

5. In Section B illustrate the structure of the skin with a model, a chart, or transparency.

6. In Sections C and D, emphasize that the generalizations on the effects of sunlight in different racial groups have many individual exceptions. Members of different racial groups can and do live in all climates.

7. With respect to Section E, the frequencies of various blood types differ in different racial groups. Thus types B and AB are very rare among American Indians. Data on racial frequencies, however, cannot be used to predict an individual's blood type. The possibility of transplants is limited by incompatibilities between individuals. These have no relationship to race.

ANSWERS TO QUESTIONS

1. **f.** The Ainu are an ancient race of white aborigines living in Japan.

2. **d.** There are many blond Israelis.

3. **b.** There are many dark Swedes.

4. **e.** Many relatively light-skinned persons consider themselves blacks or Negroes.

5. **a.** American Indians vary widely in appearance.

6. **c.** In Hawaii there has been much intermarriage among the native Polynesians, Chinese, Japanese, mainland Whites, Portuguese, Filipinos, and other groups.

7. True. Most human skin, due to the presence of melanin, is some variant shade of brown.

8. True. Very fair blonds and albinos have skin that looks pink.

9. True. This is due to failure to produce sufficient vitamin D.

10. True. Heavy skin pigmentation offers protection against strong sunlight.
11. True. Lightly pigmented skin absorbs sunlight, which leads to production of vitamin D.
12. True. The coloring matter is mainly melanin.
13. True. Under the skin there are no racial differences in pigmentation.
14. True. Class discussion should support this statement.
15. True. See TEACHING TIP 7.
16. True. Cells from the outer layer are examined in "Action Biology," *The Invisible World*, Chapter 4.
17. True. When sunburned.
18. True. This becomes apparent in flushing or blushing.
19. True. See Section B.
20. True. Scientists generally accept this, though the subject is much in dispute.

9 PEAS AND PEOPLE Pages (33) 353 - (36) 356

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. tell the story of Mendel's experimental crossing of pure tall and pure short pea plants.
b. define hybrid, dominant feature, recessive feature.
c. explain how Mendel obtained 2 types of offspring by crossing hybrids.
d. use the 3:1 ratio in solving genetic problems involving hybrid crosses.

TEACHING TIPS

1. Use the introductory picture and text to motivate the lesson. Ask students to tell their experiences in recognizing inherited features of babies in their own families. Gloss over this point, however, if your class has a noticeable number of children from broken homes.
2. The rationale of this chapter is to survey Mendel's 2 principle experiments with peas—crossing pure types having contrasting features, and crossing hybrids—and then to apply the results to a problem in human inheritance.
3. In Section A questions 1 through 3 and the 2 following paragraphs summarize the main features of Mendel's first experiment. Conduct a small amount of review and drill on the notions of genetic purity by discussing features of the grandparent vines, why the parent vines were hybrids, and dominance.
4. In Section B use questions 4 through 7 to develop the concept of a recessive, and the fact that when hybrids are crossed, 1 quarter of the offspring, on the average, show the recessive feature.
5. In Section C review the summary of Mendel's conclusions. Then use questions 8 and 9 to lead the students to apply the 3:1 ratio in explaining Mary Jane's non-tongue rolling.

ANSWERS TO QUESTIONS

1. Each type of pea vine stayed the same from generation to generation.
2. One was tall and the other was short.
3. The tall grandparent.
4. Tallness was dominant. Shortness was hidden.
5. In the offspring.
6. Three quarters or 6 out of 8.
7. One quarter or 2 out of 8.
8. Both are hybrids.
9. The non-tongue rolling hidden feature, inherited from her parents, showed up in her.
10. Dominant feature—a feature that always shows in a hybrid. Hidden or recessive feature—a feature that doesn't show in a hybrid. Hybrid—the offspring of parents with contrasting features. Pure—types that stay the same for generations.

10 ABOUT GLEEPS Pages (37) 357 - (40) 360

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. recognize that a hybrid shows the dominant genetic features.
b. do simulated experiments in genetic segregation.
c. calculate ratios from segregation experiments.

d. use correctly such terms as hybrid, dominant, recessive, and pure in discussing examples of genetic segregation.

TEACHING TIPS

1. This chapter uses imaginary gleeps to teach genetic segregation.
2. In Sections A and B emphasize discussion of the questions, which elicit these ideas:
   a. White gleeps are pure recessives.
   b. In hybrids the dominant brown color shows.
   c. Each parent passes 1 color gene to the offspring.
   (Genes are used here without detailed explanation. They are examined more fully in Chapter 12.)
3. In the Gleep Activities chips are used to represent genes.
4. In Section D apply the results from the Gleep Activities to the inheritance of pea characteristics and of tongue rolling as treated in Chapters 7 and 9, especially in discussing questions 11, 13, and 14.

GLEEP ACTIVITIES

Materials (per pair of students)
20 brown chips
20 colorless transparent chips
2 containers

Preparation of Materials
1. Purchase brown and colorless poker chips, or cut small square chips out of clear and colored celluloid, acetate, or mylar (available from most art supply stores). All chips should be the same size and shape.
2. Use large manila envelopes, paper bags, cottage cheese containers, cans, or any other kinds of containers.

Notes on Gleep Activity—Part I
In Step D, putting the chips together and looking through them simulates the effect of a dominant gene in hiding a recessive one. Thus, if a gene for an enzyme that produces a pigment (dominant gene) is present, the organism will be pigmented even though a gene for lack of the enzyme (recessive gene) is also present.

Notes on Gleep Activity—Part II
1. It is essential that students mix the chips well before each draw and return drawn chips to the proper containers.
2. In Step H show students how to tally by fives (𝍸) and record their data in the table. In addition, it is not essential to record the results from 3 teams as the table calls for. Instead, all team totals may be recorded on the chalkboard and used to calculate the ratio in Step K. Assist students in calculating ratios.

ANSWERS TO QUESTIONS

1. Pure.
2. Hybrid.
3. Alike.
4. Brown.
5. One was brown, the other was white.
6. Two.
7. Brown.
8. The brown color shows through. The white is hidden by the brown.
9. About 3:1. Grand totals will vary.
10. They were both brown hybrids.
11. In tall and short peas, and in tongue rolling.
12. The dominant features.
13. Tongue rolling is dominant.
14. Each hybrid parent has a dominant and recessive gene, but passes on the recessive gene to the offspring. The offspring has 2 recessive genes and is a pure recessive.

11 BLOOD TYPES Pages (41) 361 - (44) 364

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. tell why the right type of blood must be used in a tranfusion.
b. type blood.
c. explain the role of antibodies and red cell proteins in blood clumping.
d. name the proteins and antibodies present in each blood type.
e solve blood type inheritance problems.

TEACHING TIPS

1. You may want to discuss with your class the operation of a blood bank and the use and the value of transfusions, as well as the dangers. The students will enjoy a visit to a local hospital's blood bank.
2. The red blood cell surface proteins which initiate clumping are also called antigens or agglutinogens.
3. The questions in Section B and a certain amount of drill on the Blood Typing Chart in Section A will help students grasp the rationale of blood typing. Emphasize that the blood type

tells which proteins and safe antibodies are present. Thus, type B blood has B proteins and anti-A antibodies.

4. In Section C use questioning to emphasize the genetic background in the second paragraph. Key questions: Name the genes that affect blood type. Which genes are dominant? Recessive? In the puzzle John is type A, Rose is type A, Joan is type O, Kurt is type AB.

5. In Section D students will enjoy a simulated courtroom scene. Both Elena and Johnny have genes AA or AO, the baby has genes BB or BO. Johnny is not the father because Elena could not give the baby a B gene, and neither could Johnny. Note that blood type may sometimes prove lack of relationship, but it cannot prove relationship positively. Use examples to show this.

BLOOD-TYPING ACTIVITY

Materials (per pair of students or per group)

absorbent cotton
alcohol
disposable lancets
slides
marker
blood typing sera
anti-A and anti-B
toothpicks

Preparation of Materials

Blood typing anti-sera may be purchased from hospital or biological supply houses. Also available are somewhat more expensive blood typing kits which contain all necessary supplies.

1. Blood typing anti-sera are available from hospital or biological supply houses. Also available are somewhat more expensive kits containing all necessary supplies.

2. If your school district does not permit students to draw blood, kits containing resuspended cells may be obtained from Kemtec Educational Corp., 3514 Plyers Mill Road, Kensington, Md. 20795.

Notes on the Activity

1. CAUTION: *All parts of the activity are to be done under a teacher's supervision. Teachers should follow any special procedures required by their school district.*

2. For Step B, follow directions as given in "Action Biology," *Keeping Alive*, Chapter 1, Drawing-Blood Activity and page 2 of the *Teacher's Guide*.

3. For Steps E and G, only 1 drop of each anti-serum need be used. Many teachers prefer to distribute the serum themselves.

4. In Steps I through L a microscope is not necessary and should not be used. Demonstrate results on an overhead projector.

5. In Step L note the cautionary note included here. Since various errors are possible in typing blood, the students' results should not be taken as definitive for medical purposes.

ANSWERS TO QUESTIONS

1. Answers will vary.
2. Type B blood contains anti-A. Type A blood contains anti-B.
3. His or her own blood would clump.
4. Type A.
5. It can stop the flow of blood to vital organs
6. It can clump the patient's blood and stop the blood flow.

12 GENES ARE FOR REAL Pages (45) 365 - (50) 370

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. perform an experiment to compare the properties of mashed and smooth peas.
b. relate genes to enzymes in peas.
c. solve simple genetic problems.

TEACHING TIPS

1. This chapter enables students to visualize genes through their biochemical effects. After doing the activity, careful review of the questions in Section A will help students to understand the rationale of the activity.

2. In discussing Section B, stress the very great number of genes and enzymes we have in our body, similar to the examples observed in peas. Our genes and enzymes regulate development as well as body chemistry.

3. In discussing the genetic puzzles, ask for reasons for the solutions offered.

THE GENES-IN-PEAS ACTIVITY

Materials (per pair of students or per group)

Petri dish of sugar agar (glucose-1-phosphate)
dropper bottle of Lugol's iodine
starch suspension, bread, or potato
slide
test tube
marker
toothpicks
tissue

(per group)

dropper bottle of smooth pea extract
dropper bottle of wrinkled pea extract

Preparation of Materials

1. To prepare sugar agar add 2 g agar to 100 ml of water. Stir and bring this to a boil. Then add 0.5 g glucose-1-phosphate and stir until it is dissolved. Pour a *very thin* layer in

each Petri dish. After hardening, the Petri dishes may be stored in the refrigerator for several days. Order 1 to 2 g glucose-1-phosphate per class from a biological supply house. *Keep it tightly sealed in a freezer.*

Notes on the Activity

1. This activity depends on the fact, diagrammed in Section A, that wrinkled peas contain a genetically controlled enzyme which synthesizes starch from glucose, while smooth peas lack the gene and the enzyme.
2. For Step F bread, crackers or potato can be substituted for the starch solution.
3. To give the enzyme sufficient time to work *wait at least 30 minutes* between Steps D and K. During this time students can go over the genetic puzzles.
4. In Step M, when the dish is held up to the light, spots in the W quadrants will look bluish, and the spots in the S quadrant will look brownish.

ANSWERS TO QUESTIONS

1. White.
2. Turned blue-black.
3. Turned brown iodine color. No other change.
4. There is no starch in the mashed peas.
5. The W spots.
6. No. Only the wrinkled pea spots turned blue.
7. No. It's not blue.
8. No. We tested the peas in Step J.
9. The wrinkled peas made starch out of sugar.
10. Wrinkled.
11. Smooth peas have a gene for not making starch. Wrinkled peas have the gene for making starch.
12. She inherited 1 gene for blond hair from each parent.
13. José is a hybrid. The gene for blue eyes is recessive. He has a gene for dark eyes that shows up.
14. Free earlobes. She inherited an (A) gene from her father and an (F) gene from her mother, *but* the (F) gene is dominant.
15. The A type baby. It couldn't be the O type baby because each parent has 2 dominant genes and has no O gene to pass on.

13 WHERE ARE THE GENES? Pages (51) 371 - (54) 374

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. identify genes with chromosomes.
b. compare the chromosome numbers of various organisms, and the chromosome numbers of body cells, fertilized eggs, egg cells, and sperm cells.
c. identify dividing cells on an onion root slide.
d. arrange in order the stages of cell division.
e. describe the chromosome cycle in a dividing cell.

TEACHING TIPS

1. Page (51) 371 hints at a fundamental problem in biology which you may want to discuss a little more fully if students bring it up. Every body cell has a full set of chromosomes and therefore a full set of genes. Yet many or most genes operate only for a limited time or in a restricted situation. For example, genes controlling development may cease operating in maturity. Clearly there must be some mechanism which turns genes on and off. Biological scientists are just beginning to unravel this mechanism.
2. The classic experiment on corn chromosomes summarized in Section A was performed by Harriet S. Creighton and Barbara McClintock.
3. In the Table of Chromosome Numbers in Section B, the "full set" or "Number of Chromosomes in Each Regular Cell" is the diploid number. The "half set" found in egg and sperm cells is the monoploid or haploid number.
4. This chapter focuses on mitosis, the process which insures that every normal cell will receive its full complement of chromosomes and genes. The Chromosome Activity and the CELL DIVISION WORKSHEET teach the process.

CHROMOSOME ACTIVITY

Materials (per student)

microscope	lens tissue
microscope lamp	onion root tip slide

Notes on the Activity

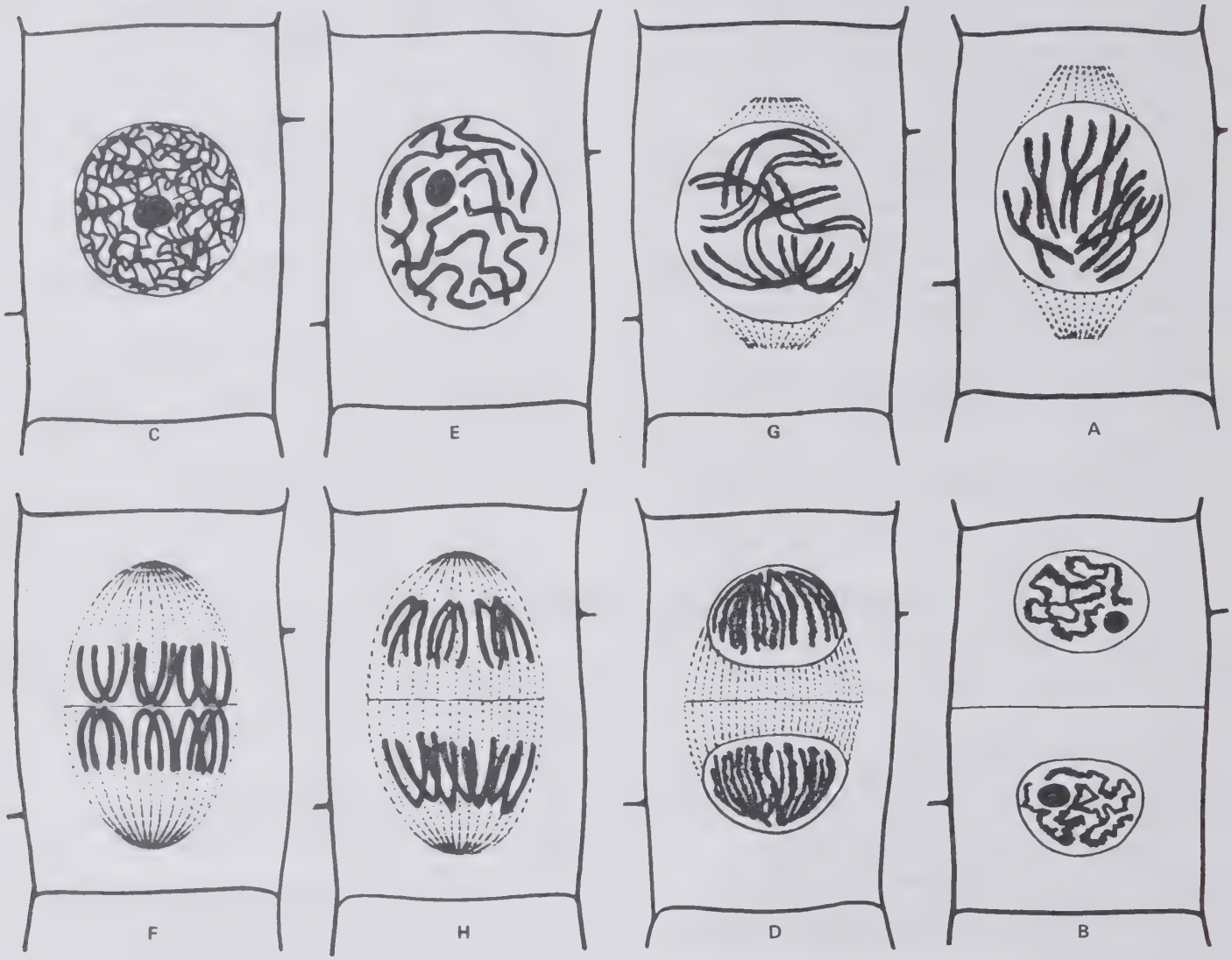
1. Students will need help in microscopically finding and identifying cells in mitosis.

Without requiring the names of the stages, ask students to find in the onion root tip Stages A to H of the CELL DIVISION WORKSHEET.

2. As noted in Step A, look for mitotic cells in the meristem region or zone of active cell division just above the root tip.

CELL DIVISION WORKSHEET

Proper order of stages:



ANSWERS TO QUESTIONS

1. All his cells. Active color genes are in skin cells.
2. In all his cells.
3. In the knob on chromosome No. 9.
4. 46.
5. Genes.
6. Made a duplicate set.
7. Disappears.
8. Middle of the cell.
9. Each end of the cell.
10. Chromosomes—genes.

14 IF THE CHROMOSOMES GO WRONG Pages (55) 375 - (58) 378

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. recognize that certain diseases have genetic causes.

b. tell what genetic counselors do.
c. count and tally sets of metaphase chromosomes.
d. identify chromosome sets as male or female, normal or abnormal.

TEACHING TIPS

1. In discussing the first 2 pages of the chapter, minimize the horrors of genetic defects, and emphasize the possibility of treating many defects, or of preventing them through genetic counseling.
2. There has been discussion in the press of criminal tendencies supposedly associated with the XXY condition (Klinefelter's syndrome). Investigation has not supported these claims.
3. PKU stands for phenylketonuria. In this genetic condition defective metabolism of the amino acid, phenylalanine, causes melanin to be secreted in the urine. The defective metabolism may also produce albinism, brain damage, and mental deficiency. Early detection and treatment may reduce the effects.
4. In considering genetic counseling, a question such as the following will stimulate interested discussion: If a couple learn they are likely to have defective children, should they adopt children rather than have their own?
5. Human chromosomes are numbered and identified, world wide, according to a standard scheme called the Denver Convention.
6. The chromosome sets shown on the CHROMOSOME SET WORKSHEET were prepared by growing white blood cells in tissue culture. The cells are treated to halt mitosis in metaphase and to cause the chromosomes to expand and spread out. The chromosome sets are then photographed, and the chromosomes cut out and arranged in order for identification and display of the karyotype. To identify the sets on page (58) 378 without cutting them up, have students write a list of numbers from 1 to 22, and add X and Y. Chromosome numbers and letters can then be checked off against the list.

ANSWERS TO QUESTIONS

1. Male has 1 X and 1 Y chromosome. Female has 2 X chromosomes and no Y chromosome.
2. Set A is from a male with mongolism or Down's syndrome. There are 3 copies of chromosome 21.
3. Set B is from an abnormal sterile male with XXY sex chromosomes. The condition is called Klinefelter's syndrome.

15 THE CODE OF LIFE Pages (59) 379 - (64) 384

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. write and transcribe a simple message in International Radio Code.
b. recognize common elements in the radio, airport, and genetic codes.
c. summarize the causal sequence from genetic code to assembly of a protein to control of a body function.
d. define a gene as a coded unit of DNA.
e. describe the structure of DNA.
f. construct a DNA model.

TEACHING TIPS

1. Deciphering the genetic code is an epochal and exciting achievement of modern biology. The chapter presents this sophisticated subject in greatly simplified form.
2. Students will enjoy sending each other messages in radio code. The coded phrase at the beginning of the chapter is "The code of life."
3. In Section A stress that the radio and the airport codes both carry messages and both use a 26-letter alphabet. As elicited by question 2, the airport code uses only 3-letter codewords.
4. In Section B look at the diagram of sections of normal and abnormal hemoglobin molecules with the class. Have students point out the resemblances and the difference. For background on red blood cells and hemoglobin see "Action Biology," *Keeping Alive*, Chapter 2.
5. In Section C ask students to compare the length of the alphabet and the length of codewords used in radio, airport, and genetic codes. Ask how the genetic code is like the other codes in function. The Selected Genetic Code lists 4 amino acids. Actually, 20 amino acids and a punctuation mark are coded.
6. For the purpose of simplicity, Section C discusses the code without distinguishing between the roles of DNA (deoxyribonucleic acid) and RNA (ribonucleic acid).
7. In Section D ask students to identify the amino acids coded by the gene in the cartoon, using the Selected Genetic Code in Section C. The amino acids are proline-glutamic acid-glutamic acid-lysine; this is part of the normal hemoglobin sequence.
8. In Section D the complementarity of "chemical letters" (nitrogen bases) is explained

only so that students will be able to construct the DNA model in the activity.

DNA-MODEL ACTIVITY

Materials (per pair of students or per group)
Cheerios breakfast cereal
thin string
toothpicks (pointed at both ends)
soda straws, white and 4 colors
ruler
scissors
ring stand with 2 rings

Preparation of Materials
Purchase and assemble materials in advance. A completed model for students to examine as they work will be helpful.

Notes on the Activity
1. Before beginning construction, each group will have to choose 4 colors of straws and work out their private key to the genetic alphabet (bases) as described in Section F. The straw-Cheerio strands represent the phosphate-sugar sequence in the DNA model.
2. If you don't have ring stands, tie the bottom of the 2 strings to a pencil, a toothpick apart, and make the model flat on the desk. Complete the model by tying the top of the strings to another pencil.
3. In Step G students must *gently* stick the toothpick into the Cheerios.
4. As students work, especially in Step G, go around to the various groups and help them understand what they are doing. Review the discussion of the genetic code and apply it to the model they are building. Note that 1 strand carries the code, the other strand carries the complement of the code. (This complementarity is essential for the replication and transcription of DNA, which are not treated here.)
5. Have students demonstrate their completed models. Ask them to translate the messages coded by their DNA, as far as possible. Use the models to review the genetic code-protein assembly-control of body function sequence.
6. To keep students from eating Cheerios, tell them that the cereal is a year old and you sprayed it with a poison to keep the bugs out. Or, have students supply their own Cheerios.
7. At the end of the activity collect the cut up straws and use them over again.
8. Alternatively, students can make DNA models out of candy, bottle caps, playing cards, gum wrappers, or anything else. Glue, wire, or thread can be used to hold the model together. The important thing is the color coding of the 4 bases, sugar, and phosphate.

ANSWERS TO QUESTIONS

1. 26.
2. Words in the radio code can be any length. Words in the airport code have only 3 letters each.
3. There is a valine where a glutamic acid should be.
4. CCA-GAA-GAA-AAA.
5. GUA instead of the first GAA.

SUPPLIES AND EQUIPMENT

Large Equipment

Lamps, microscope
Microscopes, compound
Microscopes, dissecting
Refrigerator

Small Equipment

Dissecting needle
Dropper bottles
Droppers (optional)
Filter paper
Hammer
Lancets, disposable sterile
Lens tissue
Magnifiers (optional)
Petri dishes
PTC paper
Ring stands
Ring stand clamp and ring clamp
Rulers
Scissors
Screwdriver
Slides
Test tubes, small
Yardsticks or metersticks

Chemicals

Agar
Alcohol
Blood typing sera anti-A and anti-B
Glucose-1-phosphate
Lugol's iodine solution
Starch

Biological Materials

Bones, chicken
Peas, smooth
Peas, wrinkled
Pits, fruit
Shells, clam or nut
Slime mold (Physarum)

Prepared Slides
Onion root tip

Consumables Obtainable Locally

Acetate or celluloid, clear
Acetate or celluloid, colored
Aluminum foil, heavy duty
Cheerios

Cotton balls, absorbent
Envelopes, large
Marker, glass
Oatmeal
Plaster of Paris
Q-Tips
Soda straws, white and 4 colors
Spoons, plastic
String, kite
Toothpicks (pointed at both ends)
Vaseline
Vinegar

AUDIOVISUAL MATERIALS

For meaning of abbreviations, see *Teacher's Guide*, page 131.

Cell Division and Growth. B&W, 13 min., Abbott Laboratories. (The role of mitosis in the life of the cell.)

The Chromosomes of Man. B&W, 20 min., EBE.

Culturing Slime Mold Plasmodium. B&W, 6½ min., Thorne Films. (Shows technique.)

Darwin and the Theory of Natural Selection. Color or B&W, 13 min., Coronet.

Darwin's Finches: Clues to the Origin of Species. Color or B&W, 10 min., Film Associates of California. (Uses Darwin's study of the Galapagos Island finches to illustrate the mechanism of evolution.)

The Dinosaur Age. Color or B&W, 14 min., Film Associates of California. (Work of museum paleontologists.)

Dinosaurs: Giant Reptiles of the Past. Filmstrip, Popular Science.

The Dinosaurs: Skeleton Assembly. Film Loop, EBE.

The Dividing Cell. Film Loop, BFA.

DNA Structure: Backbones and Bases. Film Loop, BFA.

Formation of Sedimentary Strata. Film Loop, EBE.

Fossil Story. Color, 19 min., Shell Oil Co. (Types of fossils and their economic uses.)

Fossils. Sound Filmstrip Series, EBE.

Fossils: Clues to Prehistoric Times. Color or B&W, 11 min., Coronet.

Fossils from Site to Museum. Color or B&W, 11 min., Coronet.

Fossils: Parts I and II. Film Loop, BFA.

From Water to Land. B&W, 28 min., MGH-AIBS Series. (Stages in evolution from aquatic organisms to land-dwelling animals.)

The Galapagos. Filmstrip Series, BFA.

Gene Action. Color, 16 min., EBE. (Genetic basis for phenylketonuria (PKU).)

Genetic Investigations. Color or B&W, 12 min., Indiana.

Genetics: Chromosomes and Genes. Color or B&W, 16 min., Coronet.

Genetics: Human Heredity. Color or B&W, 14 min., Coronet.

Genetics: Improving Plants and Animals. Color or B&W, 14 min., Coronet. (Shows various methods that are used.)

Genetics: Mendel's Laws. Color or B&W, 14 min., Coronet.

Grand Canyon. Color, 29 min., Walt Disney. (The musical accompaniment to this scenic picture is the Ferde Grofe "Grand Canyon Suite.")

Grand Canyon: Record of the Past. Film Loop, BFA.

Gregor Mendel. Filmstrip, EBE.

Heredity. B&W, 11 min., EBE. (Simple presentation of basic Mendelian heredity.)

Heredity and Environment. Color or B&W, 11 min., Coronet. (Contrasts effects of the two factors; shows Mendel's work.)

Heredity and Environment. B&W, 30 min., Indiana.

Heredity: Mendel's Experiments. B&W, 30 min., Indiana.

Heredity: The Sex Chromosomes. B&W, 30 min., Indiana.

How Animals Change. B&W, 20 min., Time-Life Films. (Discusses ways some animals change over long periods of time, and evolutionary significance.)

How Living Things Change. Color or B&W, 14 min., Coronet. (Survey of evolution and the theories that explain it.)

Human Heredity. Color, 22 min., Churchill-Wexler. (Survey of the topic.)

Inheritance in Man. Color or B&W, 28 min., MGH-AIBS Series. (Rh, blood type, ability to taste PTC, and eye color inheritance.)

Inheritance in Populations. Color, 16 min., MGH. (Skin color, blood groups, gene pools.)

Interactions in Heredity and Environment. Color, 16 min., MGH-AIBS Series. (Identical and nonidentical twin studies; animal and plant experiments.)

It Runs in the Family. B&W, 30 min., Association Films. (Simple presentation of human heredity.)

Laws of Heredity. Color, 15 min., EBE. (Basic Mendelian genetics.)

Living Things Through the Ages. Filmstrip Series, EBE.

Mammals and Man. Filmstrip, International Film Bureau.

Mendel's Experiments. B&W, 30 min., Association Films. (Absorbing and detailed account of Mendel's work.)

Mitosis. Color or B&W, 24 min., EBE. (Uses photomicrography to emphasize the details and the importance of the process.)

Mitosis—Animal and Plant. Film Loop, EBE.

Mutation—Induced Gene Mutations. B&W, 28 min., MGH. (Nature and mechanisms of mutations.)

Natural Selection. Color or B&W, 16 min., EBE. (Simple presentation of the basic concept.)

Natural Selection and Adaptation. Color or B&W, 28 min., MGH-AIBS Series. (Evolution today in the development of antibiotic-resistant bacteria and DDT-resistant insects.)

Prehistoric Animals. Color or B&W, 13 min., Productions Unlimited. (Survey on a simple level.)

Prehistoric Animals of the Tarpits. Color, 15 min., Film Associates of California. (Story of the La Brea tarpits.)

Prehistoric Times: The World Before Man. Color or B&W, 11 min., Coronet.

Radiation and the Population. B&W, 29 min., Indiana Univ. and U.S. Atomic Energy Commission. (Mutation and genetic damage resulting from radiation.)

Rocks and the Record. B&W, 28 min., MGH-AIBS Series. (Dating of rocks and fossils.)

Species: Stability and Change. B&W, 28 min., MGH-AIBS Series. (Definition of species and role of isolation in species formation.)

The Story of Fossils. Filmstrip, Popular Science.

Story in Rocks. Color, 18 min., Shell Oil Co. (Deals with work of paleontologists.)

The Thread of Life. Color, 60 min., American Telephone & Telegraph. Available from local phone company. (Excellent film on DNA, structure of chromosomes, genes and human heredity.)

The Voyage of the Beagle. Filmstrip, BFA.

Voyage to the Enchanted Isles. Color, 54 min., BFA.

REPRODUCTION

CONTENTS

PLAN AHEAD for the following lessons:

Chapter 1 Duplicate copies of Reproductive System Word Puzzle.
2 Duplicate copies of alphabet cards.
6 Duplicate copies of HORMONE BINGO WORKSHEET.
8 Prepare Petri dishes of sugar-agar 2 days ahead. Sprinkle the Petri dishes with ripe pollen 1 day ahead. Order flowers for delivery 1 day ahead.
9 Have a variety of fruits on hand the day of the lesson.
10 Start incubating fertile hens' eggs 3 weeks in advance of the lesson. Several days in advance, ask students to bring in eggshells for the sculpture activity.
11 Plan to have litters of mammals available the day of the lesson.
15 Duplicate copies of LET'S RAP WORKSHEET (optional).

1 THE FUTURE FATHER Pages (3) 387 - (6) 390

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. define sexual reproduction.
b. define sperm cells.

c. describe the male reproductive system.
d. trace the passage of sperm through the male reproductive system.
e. use "clean words" when discussing the male reproductive system.

TEACHING TIPS

1. Divide the class into small groups to discuss the questions at the end of the chapter. Then have each group present and explain its answers to the class. Lead a discussion of the topic "What is a mature attitude toward sex?"
2. Place a question box in the room for anonymous questions. Discuss students' questions without embarrassing personal reference.
3. The labels for the diagram of the male reproductive system on page (6) 390 are: #1 prostate gland, #2 tube, #3 testis, #4 foreskin, #5 penis, and #6 scrotum.
4. The REPRODUCTIVE SYSTEM WORD PUZZLE (blackline master #11) reinforces the use of "clean words." After the students find the 18 reproductive words on the list, challenge them to find additional words.

ANSWERS TO QUESTIONS

1. Answers will vary.
2. Yes, they are too sexually stimulating.
3. No. He is still developing socially, has not completed his education or job training, and would not be able to support a family.
4. Testis or testes.
5. Tube, prostate.
6. Semen or liquid.

2 THE FUTURE MOTHER Pages (7) 391 - (10) 394

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. define the word ovulation.
b. describe the female reproductive system.
c. describe the human menstrual cycle.
d. use "clean words" when discussing the female reproductive system.

TEACHING TIPS

1. Go over the menstrual cycle diagram on page (9) 393.
2. You may want to tell your students that the permanent cessation of menstruation is called menopause.
3. I.U.D. stands for intrauterine device. Sterilization in males is called vasectomy; in females it is tubal ligation.
4. To make alphabet cards for the REPRODUCTION WORD GAME, duplicate blackline master #12. Cut out the letters. Distribute and store them in large envelopes.

Materials
alphabet cards
scissors
jars, boxes, or large envelopes

ANSWERS TO QUESTIONS

1. Release of an egg from the ovary.
2. Ovary. Fallopian tube, uterus or womb.
3. It dies and breaks down.
4. Breakdown and shedding of the uterus lining.
5. Accept any or no attempt to trace the cycle.

3 THE BABY COMES Pages (11) 395 - (14) 398

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe the fertilization process as it occurs in humans.
b. describe the early embryo.
c. describe the function of the umbilical cord and the placenta.
d. describe the birth of a baby.

TEACHING TIPS

1. You may want to stress that (a) the function of the amnion is protection, and (b) the mother's blood and the baby's blood normally do not mix.
2. Your students will enjoy this chapter. Have them first answer the questions in writing, and then discuss their answers orally.
3. Discuss questions placed in question box.

ANSWERS TO QUESTIONS

1. When she misses her period.
2. The baby gets its food and oxygen from the mother through the cord and placenta.
3. The mother feels labor contractions, and the bag of water may break.

4. The (umbilical) cord connects the baby to the placenta. The navel is the place on the baby's body where the cord is attached. The afterbirth includes the placenta and the stub of the cord.

5. Questions will vary.

4 PICTURE STORY OF DEVELOPMENT Pages (15) 399 - (20) 404

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe the stages of human fetal development.

b. measure the pictures and compute the size of the baby at various stages in its development.

c. plot a graph to show the baby's increase in crown-to-rump length during its development.

TEACHING TIPS

1. The activity begins with the second figure on page (16) 400.

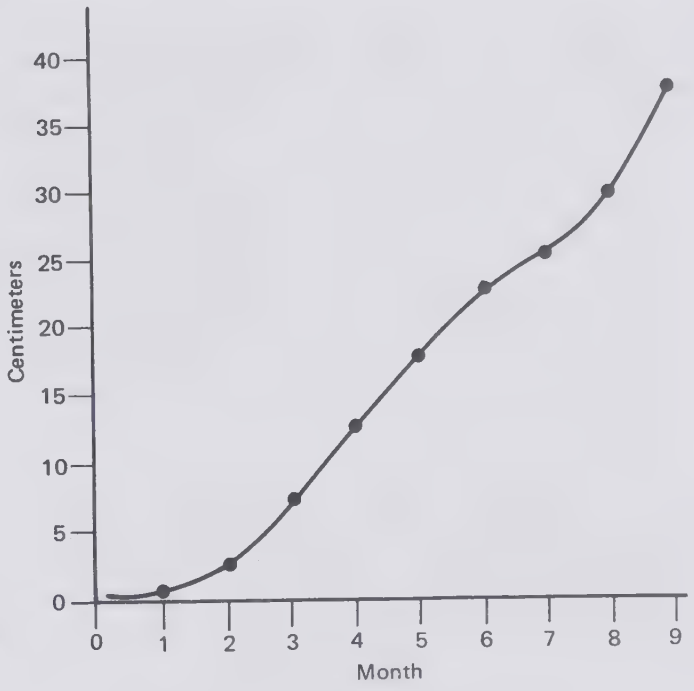
2. Assist the students in calculating the crown-to-rump lengths.

The crown-to-rump lengths are:

Month	*Picture Length in Centimeters*	*Picture Scale*	*Actual Length in Centimeters*
1	1.3	5x actual size	0.26
2	1.3	$\frac{1}{2}$ " "	2.6
3	2.5	$\frac{1}{3}$ " "	7.5
4	3.2	$\frac{1}{4}$ " "	12.8
5	4.3	$\frac{1}{4}$ " "	17.2
6	5.6	$\frac{1}{4}$ " "	22.4
7	6.2	$\frac{1}{4}$ " "	24.8
8	7.7	$\frac{1}{4}$ " "	30.8
9	7.5	$\frac{1}{5}$ " "	37.5

3. Show the students how to plot a line graph.

Graph of Crown-to-Rump Developing Baby



4. Students should understand that over-all length of baby comprises crown-to-rump length plus length of legs.

MEASURE-THE-BABY ACTIVITY

Materials

ruler
graph paper

5 CHEMICAL MESSENGERS Pages (21) 405 - (22) 406

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. explain the function of hormones in simple terms.

b. describe in general terms how birth control pills work.

c. describe the functions of the female and male sex hormones.

TEACHING TIPS

Divide the class into small groups to discuss the questions at the end of the chapter. Then have each group report conclusions to the class, orally or in writing.

ANSWERS TO QUESTIONS

1. The pill stops ovulation.
2. They carry messages to the different parts of the body.
3. Answers will vary.
4. Answers will vary.
5. Answers will vary.

6 MORE MESSENGERS Pages (23) 407 - (26) 410

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. locate and name the glands that secrete adrenalin, thyroid hormone, and insulin.
b. describe the functions in the body of adrenalin, thyroid hormone, and insulin.
c. describe the condition known as diabetes, its treatment, and its cause.
d. distinguish between duct and ductless glands.
e. describe the function of hormones of the master gland.

HORMONE-BINGO WORKSHEET

Distribute duplicated copies of the HORMONE-BINGO WORKSHEET (blackline master #13). Students can choose 16 out of the 20 terms listed, and write them in any order on their cards. Use small pieces of paper as markers. Make up questions for the bingo game from Chapters 5 and 6. Questions with 2 or more answers are permissible. When a student calls "bingo," check both the marker answers and the questions while the class listens. If a student calls "bingo" and does not have it, he or she is disqualified from that round. For getting bingo, give the students small rewards, such as pieces of candy. After a few rounds, have the students switch cards with their neighbors.

ANSWERS TO QUESTIONS

1. In emergencies it prepares the body either to fight or to run.
2. From animals like the cow or pig.
3. Female and male sex hormones, adrenalin, thyroid hormone, and insulin.
4. It controls other glands.

7 LOOK ALIKES Pages (27) 411 - (30) 414

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. compare the development of fraternal and identical twins.
b. state the difference between identical and fraternal twins.
c. calculate the mathematical odds for multiple births, e.g., triplets, quadruplets, and quintuplets.

TEACHING TIPS

1. Help students who have difficulty answering worksheet questions 2 and 5.
2. Discuss results of twin studies (separation of identical twins) on the relative bearing of heredity and environment. These studies indicate that every trait is influenced both by heredity and by environment.

QUINT WORKSHEET

1. Yes. They have the same webbed toes, blood type, eye color, eye pattern, eyebrow color, eyelashes, hair color, wavy hair form, and complexion; they look alike.
2. 
3. Emilie and Marie. They have certain traits in common which the other Dionne quintuplets do not have, e.g., manner of holding objects, far-sightedness, and cross-eyes.

4. Emilie.
5. $85 \times 85 \times 85 \times 85 =$
   $85 \times 85 =$ Triplets are expected once in every 7,225 births.
   $7225 \times 85 =$ Quadruplets are expected once in every 614,125 births.
   $614125 \times 85 =$ Quintuplets are expected once in every 52,200,625 births.
6. Answers will vary. The Baer quintuplets were born in Illinois in 1973.

ANSWERS TO QUESTIONS

1. They come from the same fertilized egg.
2. After the fertilized egg or early embryo split in half, each half embryo developed a little bit differently.
3. They are identical twins in which the half embryos did not separate completely.
4. Fraternal.
5. Answers will vary. Usually twins are close to each other emotionally and get along very well.

8 FLOWER POWER Pages (31) 415 - (36) 420

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. dissect a flower, identify the parts, and describe the function of each part.
b. distinguish between pollination and fertilization.
c. describe the different kinds of pollination.
d. describe the life cycle of a flowering plant.

TEACHING TIPS

1. A visit to a local florist would make an interesting 1 hour field trip. Florists can talk about the various kinds of flowers, how they are grown, and where they are grown; they can demonstrate floral arrangement and the making of corsages. They can discuss vocational opportunities. If you cannot make a field trip, ask your florist to visit the class. This is good public relations for the florist.
2. Have your students examine a variety of flowers and in table form record the name of the flower, number of petals, number of sepals, number of pistils, and number of stamens.

FLOWER ACTIVITY

Materials (per pair of students)
gladiolus or tulip flower
scalpel or single-edged razor blade
paper towel or cardboard
dissecting microscope (at least 1 in the room)
Scotch tape
Petri dish of sugar-agar
talcum powder (optional)
hand lens (optional, but recommended)
forceps (optional)

Preparation of Materials

1. Use only perfect flowers which clearly show all the floral parts. Any of the following are good: gladiolus, tulip, sweet pea, or fuchsia. Florists may be willing to donate, or sell at a discount, their old, "faded" flowers.
2. The successful germination of pollen grains may present some difficulty, since different species have different requirements. Tulip pollen is relatively easy to germinate. Use only pollen grains from "ripe" anthers. To prepare the sugar-agar, use 2 g agar for every 100 ml of water. Add agar to boiling water and dissolve in it 10 g sugar (sucrose). Pour a thin layer of the hot sugar-agar into Petri dishes. The dishes can be stored in the refrigerator for several days until needed. Be sure to try this procedure in advance. Some pollens require lower sugar concentration, 2 to 5 g per 100 ml of water; other pollens require higher concentration, 15 to 20 g per 100 ml of water. The day before the activity, sprinkle ripe pollen on the sugar-agar Petri dishes. Cover dishes and keep them at room temperature.

Notes on the Activity

1. To teach or to review use of the microscope, see "Action Biology," *The Invisible World*, Chapters 1 and 2.
2. After Step C you may want the students to remove the sepals, tape them on their paper, and label them.
3. Set up 1 or 2 dissecting microscopes for Steps E and L.
4. A hand lens is useful, especially for Steps E, I, K, and L.
5. Caution students to do all cutting on paper towels or cardboard.
6. In Step G students can demonstrate the stickiness of the stigma by sprinkling a few grains of talcum powder on it.
7. For Step K, if you do not have flowers whose stigma show pollen, brush some pollen onto the pistil of a few flowers.
8. Have the students make drawings of pollen grains before and after germination.

9. Check the students' dissection and mounting of the floral parts.

ANSWERS TO QUESTIONS

1. Pollination is the transfer of pollen from the anther to the top of the pistil.
2. Wind or insects.
3. The attractive smell and sweet juices of the flower.
4. Fertilization.
5. The 3 stages of reproduction are: pollination, growth of pollen tube down through the pistil, and fertilization.

9 DON'T EAT THIS FRUIT Pages (37) 421 - (40) 424

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. define the term "fruit."
b. state the functions of fruits.
c. describe how fruits are formed.
d. describe a seed and several mechanisms of seed dispersal.
e. examine and describe several different kinds of fruit.

TEACHING TIPS

Have the students examine and draw the parts of certain seeds (soaked kidney, lima, or pinto beans). Students should label protective coat, stored food, and embryo.

FRUIT WORKSHEET

Materials

single-edged razor blade
knife (for teacher use only)
hand lens
variety of fruits

Notes on the Activity

1. Students are surprised to find how many common vegetables are really fruits. Any of the following may be used: apple, orange, peach, green bean, tomato, peanut in shell, green pepper, cucumber, peas in pod, olive with pit, walnut in shell, pear, squash, apricot, eggplant, nectarine, pumpkin, plum, coconut, acorn, blueberry, strawberry, maple key.

2. Give each group of students several different fruits to examine, but each student should write up only 3 of the fruits. An alternative way of doing the worksheet is to set up stations around the room and to have students go from station to station.

3. Assist students in properly cutting specimens in half. By slicing certain fruits (tomato, cucumber, and pepper), you can reduce costs.

4. Help students find the flower parts.

5. Sample answer:

Table of Fruits and Seeds

Name of fruit	*Tomato*	*Maple Key*	*String Bean*	*Peanut*
Fruit dry or juicy?	juicy	dry	juicy	dry
Is fruit edible?	yes	no	yes	no
Are seeds edible?	yes	no	yes	yes
Number of seeds?	many, 1000	2	5–8	2
Are flower parts (sepals, petals, pistil, stamens) still attached to fruit?	yes sepals sometimes	no	yes	no
How is seed protected?	fleshy covering	leathery coat	fleshy covering	hard shell
Does fruit travel? How?	no, but it may roll	yes, wind	no	no
How does seed travel?	animals eat fruit or seed, seeds come out with feces	wind	yes, pushed out of dry bean	animals carry it and bury it

ANSWERS TO QUESTIONS

1. Like all other fruits, a tomato contains seeds.
2. Baby plants.
3. By farmers, wind, animals.

10 CRACKING EGGS Pages (41) 425 - (44) 428

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. distinguish between internal fertilization and external fertilization.
b. identify the parts of a non-fertilized chicken egg.
c. identify the parts of chick embryos at various stages of development.

TEACHING TIPS

1. Discuss the structure of the chicken's reproductive tract.
2. Glue or paste, paint or egg dye, and decorative materials will be needed for eggshell sculptures or collages. Let students provide materials. Eggshells can be easily cut with cuticle scissors if clear nail polish is applied to parts of the shell first.

EGG ACTIVITY—PART I. THE SUPERMARKET EGG

Materials (per group of 2 or 3)
unfertilized egg
forceps
scissors
dish or small bowl

Notes on the Activity

1. Use the cheapest, smallest eggs that you can obtain.
2. In Step D there is less chance of the yolk breaking if you pour the egg into a dish of water.

EGG ACTIVITY—PART II. THE FERTILE EGGS

Materials (per pair of students)
incubating hen's egg
dish or small bowl
watch glass or small Petri dish for examining embryo
filter paper
fine pointed scissors
fine pointed forceps
hand lens
dissecting microscope (1 or 2 in the room)
0.9% saline solution at 39° C

Preparation of Materials

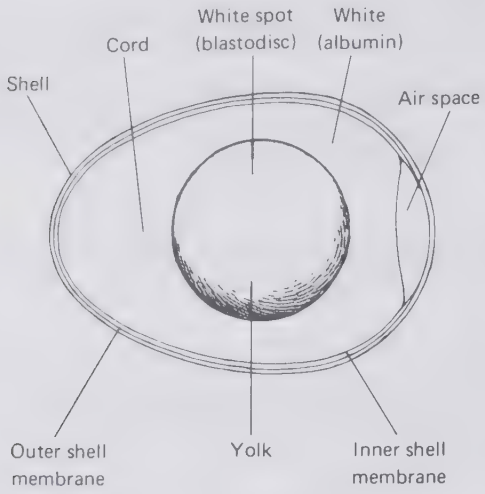
To prepare 0.9% saline solution, dissolve 9 g sodium chloride in 1 liter of water.

Notes on the Activity

1. Obtain fertile eggs from commercial hatcheries (try the Yellow Pages) or poultry farms. Eggs should be kept cool (about 10° C (50° F)) and used immediately, as viability drops if the eggs are kept more than one week. Fertile pigeon eggs may also be available from breeders and fanciers; the incubation period is 17 days.
2. Eggs should be incubated at 37° to 38° C (99° to 101° F). See that there is a pan of fresh water in the incubator and that air circulation is adequate. Turn the eggs daily, or the embryos may stick to the shell.
3. On the day of the laboratory activity the students should examine the following stages of development: 1-day (only a few eggs), 2-day, 3-day, 4-day, 5-day, 6-day, 7-day, and 10-day or older. (CAUTION is advisable in letting the students see 10-day or older chicks. Some students are shocked when a mature chick embryo is exposed and allowed to die.) Allow some eggs to hatch. Use a schedule of incubation that will provide chicks at the proper stage of development on the day you want your class to use them. Write on the shell of each egg the date and time incubation begins.
4. If you cannot obtain fertilized eggs, or if the fertilized eggs fail to develop, use prepared whole-mount slides of 24-hour, 33-hour, and 72-hour chicks. These can be obtained from biological supply houses.
5. Each team should open an egg with a different stage embryo in it. Have extra eggs available for teams which do not find embryos. Students should observe the different stages and complete the EGG WORKSHEET.
6. In Step H there is less chance of the yolk breaking if you pour the egg into a dish of saline solution.
7. The chick's heart will beat for only a short period of time if plain tap water is used instead of the saline.

EGG WORKSHEET

1. SUPERMARKET EGG



2. **Chick Development**

Part or Event	*Day of Incubation When First Seen*
Brain	1st day
Beating heart	1st day
Definite eyes	5 days
Blood vessels	1st day
Wing buds	3 days
Leg buds	3 days
Tail	3 days
Sac enclosing embryo	4–5 days
Sac containing wastes	4–5 days
Muscle blocks	1st day
Movement of chick	10 days

Expect variations for days of incubation.

ANSWERS TO QUESTIONS

1. Yes. Protection.
2. They hold the yolk in position. Thus the developing embryo is always above its food supply.
3. It is not fertilized.
4. Answers will vary depending on stage of development.
5. Answers will vary depending on stage of development.
6. Answers will vary depending on stage of development.
7. Answers will vary depending on stage of development.

11 THE HIGHEST ANIMALS Pages (45) 429 - (48) 432

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. describe the characteristics of a mammal, and give examples of mammals.

b. observe and describe the kind and amount of care provided for newborn mammals.

TEACHING TIPS

1. This is a relatively unstructured exercise in an area which fascinates adolescents, and which therefore deserves a place in the curriculum. In addition to the experience and the factual knowledge that may be acquired, the use of small mammals helps develop in the youngsters a sympathetic and humane attitude toward animals. The teacher must be careful to protect both the animals and the students.
2. Students should observe only caged animals, and should keep their hands out of cages. Whenever animals are handled, heavy gloves should be worn.
3. Either do the exercise as a class activity or divide the class into groups. If you divide the class, assign each group to a cage. Emphasize the importance of reasonably quiet observation. Students should remain at the cage until directed to move slowly to the next cage.
4. A behind-the-scenes visit to a local veterinarian or pet store would make an interesting field trip. If you cannot make the trip, ask a resource person to visit your class. Such a visit is good public relations for the local pet store keeper or veterinarian. Ask the speaker to discuss his or her work and the vocational opportunities in the field.
5. For students to observe the young, it is best to move the bedding aside.
6. Most mammals breed best in a quiet laboratory preparation room.
7. If you don't have babies available, let the class observe the behavior of mature rabbits, white mice, gerbils, or guinea pigs and write a short paragraph about their observations.
8. Ask your students to identify mammals in the figure on page (45) 429.
9. Discuss baby care by other mammals such as dogs, cats, or human beings.

Materials

mice, gerbils, or hamsters in cages, with litters of different ages
heavy gloves

ANSWERS TO QUESTIONS

1. The nest is made by making a depression in the bedding. Often the nest is covered.
2. Answers will vary. Young rodents are born hairless; their eyes are closed; they are unable to move except for squirming and nursing; they are clumsy.
3. Babies suckle from mother's nipples.
4. Young which are able to crawl will leave the nest. They struggle and compete with each other for nursing positions.
5. Mothers allow young to nurse; they groom the young; they pick up and return to the nest any young which crawl out. When disturbed, they may reject their young.
6. Answers will vary. They are the most highly evolved animals; they care for their young; they have various patterns of behavior.
7. Mammals nurse their young; the young are cared for and carefully protected; the eggs are fertilized internally and they develop internally. (The duck-billed platypus is an exception.)
8. Yes. Only an intelligent animal would be able to care for its young.

12 MASCULINE AND FEMININE Pages (49) 433 - (52) 436

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. discuss masculine and feminine roles in today's society.
b. distinguish between masculine and feminine roles, and express opinions about these roles by completing the worksheet.
c. indicate that they recognize the role and worth of the other sex in today's society.

TEACHING TIPS

1. Have your students read and discuss each of the quotations.
2. After your students do the worksheet, divide the class into groups. Each group should select the items it wants to discuss in class.
3. An alternative way to use the worksheet is to have students answer it on their own, and then to hold a class discussion.

MASCULINE-FEMININE WORKSHEET

1. Since the answers are the students' opinions, there are no correct answers.
2. The purpose of the worksheet is to enable students to express their opinions about masculine and feminine roles. A discussion of the worksheet should help students to reach some intelligent conclusions concerning the proper role of each sex in today's society. Correlate the masculine and feminine roles in society with the biological role of the male and female in nature. Refer back to Chapter 11.

13 ACTING IT OUT Pages (53) 437 - (56) 440

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. project roles expressing his or her feelings about the place of males and females in today's society.
b. indicate a perceptive view of masculine and feminine roles in today's society.

TEACHING TIPS

1. Comparison of male and female roles is a useful addition to the biology curriculum. This relevant topic is of concern both to adolescents as they search for their own identities and to society in general. Role-playing is the technique used to teach this topic.
2. The beginnings of 6 short playlets are indicated. Divide the class into 6 groups. Each group must decide how it wants each scene to develop and who will play the several roles. If they wish, the groups may add additional characters or they may change the scene. One member of each group should read the scene to the class before the group acts it out. There is a minimum of 21 active participants in the lesson.
3. Do not be surprised if the students at first need a little coaxing to play roles. Choose as the first role players a group which is enthusiastic. Assist groups that need help.

4. Discuss each presentation in light of the roles that males and females play in today's changing society. The questions on page (56) 440 provide guidelines for the discussion.

14 BOY OR GIRL Pages (57) 441 - (60) 444

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. distinguish between the X and Y chromosomes.
b. describe the role of the X and Y chromosomes in sex determination.
c. state that humans have 23 pairs of chromosomes.
d. state that chromosome reduction produces sperm and eggs with 23 chromosomes each.

TEACHING TIPS

1. For statistical reasons the cards should properly be returned to their respective envelopes after each pull. But for pedagogical reasons (e.g., the possibility of placing the wrong card in an envelope), do not have the students return the cards to the envelopes after each choice.
2. A more detailed discussion of chromosomes is found in "Action Biology," *Children and Ancestors*. If the students ask about chromosomes, explain briefly that they are structures which carry the hereditary material, but defer a detailed discussion.
3. At the end of the BOY OR GIRL GAME have the students return the cards to the proper envelope.
4. You may wish to discuss with your class the difficult concept of meiosis.

Materials (per pair of students)
envelope labelled "Mother" containing 30 cards or slips of paper marked X
envelope labelled "Father" containing 15 cards or slips of paper marked X and 15 cards or slips of paper marked Y

ANSWERS TO QUESTIONS

1. Female.
2. Male.
3. Half the sperm carry the X chromosome, the other half carry the Y chromosome.
4. Yes. Pull cards only from the "Father" envelope.
5. Answers will vary.
6. Answers will vary. Show the students how to do percentages. Short cut: Since we are dealing with 25 examples, the percentage of boys will equal the number of boys times 4; the percentage of girls equals the number of girls times 4.
7. The sperm determines the sex of the baby.
8. Answers will vary, but should be around 50% for boys and around 50% for girls. To calculate class percentages, students will have to add up the percentages from each team in the class and divide that figure by the total number of teams. You may find it best to work out these percentages with the class.
9. Answers will vary. Because of chance, answers should be pretty close.
10. There are an equal number of boys and girls in the world because, presumably, half the sperm which determine the sex contained the X chromosome and half contained the Y chromosome. This presumption is only partially true, since 106 boys are born for every 100 girls born. We do not know the reason for this.
11. No. But his third wife Queen Farah gave birth to 2 boys and 2 girls.
12. This can be explained on a statistical basis. See the table below.

Number of Consecutive Children	*Odds on All Being Same Sex*
1	1 in 2
2	1 in 4
3	1 in 8
4	1 in 16
5	1 in 32
6	1 in 64
7	1 in 128
8	1 in 256
9	1 in 512
10	1 in 1024

15 THE SILENT HANGUP Pages (61) 445 - (64) 448

BEHAVIORAL OBJECTIVES

After completing the reading and activities, and when asked to demonstrate, diagram, or respond either orally or in writing, the student should be able to . . .

a. recognize the seriousness of the VD problem.
b. describe the causative agents of syphilis and gonorrhea.
c. describe the symptoms of gonorrhea.
d. describe the symptoms in 3 stages of syphilis.
e. describe the treatment of VD.
f. tell how people get VD.

TEACHING TIPS

1. If your students have been "over-exposed" to this topic, do not dwell on it too long.
2. Students may be reluctant to discuss this subject. Ask for questions to be placed in the question box. Then discuss these questions with the class.
3. Although moralizing will not do much good, stress that the only sure way to avoid VD is to avoid sex outside of marriage.
4. Discuss the graph on page (61) 445. Stress the epidemic proportions of VD.
5. Stress that early detection and treatment can cure VD. Although VD can be cured, the damage it causes cannot be corrected if the disease is not treated early.
6. Invite the school nurse or a local physician to discuss venereal disease.

ANSWERS TO QUESTIONS

1. VD is spread by direct sexual contact.
2. In the third stage it imitates other diseases. Also, it seems to cure itself, but it really just remains hidden and continues to damage the body.
3. Answers may vary.
4. John became infected because he had sexual contact with Mary. Mabel did not get infected for any of the following reasons: John's syphilis was not in the contagious stage; John used a condom during sexual contact; John was cured by a medical doctor before she had sexual contact with him.
5. a. There are 5 different venereal diseases.
   b. A bad cold goes away by itself, gonorrhea does not.
   c. There is no lasting immunity against syphilis. You can get the disease over and over again.
   d. The only safe treatment is by a medical doctor.
   e. An infected pregnant woman can give VD to her unborn baby.
   f. When the sores of syphilis disappear, the disease remains in the body. Syphilis spreads secretly for years, attacking the nervous system and other parts of the body.
   g. You can have both diseases together because they are caused by different germs.

"LET'S RAP" WORKSHEET (blackline master #14; optional)

This worksheet gives the class an opportunity to discuss some hush-hush topics in sex education. It allows students to exchange and clarify their ideas. Hopefully, class discussion about these topics will enable students to develop healthy, socially acceptable ideas about sex. After the students anonymously fill in the worksheet, tally the results. Then hold a class discussion.

SUPPLIES AND EQUIPMENT

Large Equipment

Cages, animal
Incubator
Lamps, microscope
Microscopes, compound
Microscopes, dissecting
Refrigerator

Small Equipment

Dishes, culture, 11 cm diameter
Filter paper
Forceps
Gloves, heavy
Hand lenses
Knife
Petri dishes
Razor blades, single-edged
Rulers, small
Scalpels
Scissors

Chemicals

Agar
Sodium chloride
Sucrose

Biological Materials

Eggs, fertilized chicken
Flowers, gladioli
Mice, hamsters or gerbils

Prepared Slides

Chick embryo, 12-hour (optional)
Chick embryo, 24-hour (optional)
Chick embryo, 33-hour (optional)
Chick embryo, 72-hour (optional)

Consumables Obtainable Locally

Cardboard
Eggs
Egg dye (optional)
Envelopes, large
Envelopes, small
Fruits and vegetables, assortment: apple, orange, green bean, tomato, peanut in shell, green pepper, cucumber, peas in pod, olive with pit, walnut in shell, pear, squash, apricot, eggplant, nectarine, pumpkin, plum, coconut, acorn, blueberry, strawberry, maple key
Glue (optional)
Graph paper
Paint (optional)
Paper towels
Talcum powder
Tape, cellophane

AUDIOVISUAL MATERIALS

For meaning of abbreviations, see *Teacher's Guide*, page 131.

About Venereal Disease. Filmstrip, BFA.

Angiosperms—The Flowering Plants. Color or B&W, 21 min., EBE. (From flower to fruit in seed plants.)

Animal Reproduction. Film Loop Series, Ealing.

Asexual Reproduction. Color or B&W, 17 min., Indiana. (Survey of asexual reproduction in protists and plants.)

Basic Nature of Sexual Reproduction. Color or B&W, 17 min., Indiana Univ. (Refers to both plants and animals.)

Biography of the Unborn. B&W, 17 min., EBE. (Human development.)

Chromosomes and Sex. Color or B&W, 28 min., MGH-AIBS Series. (Discusses sex determination, sex ratios, and sex linked inheritance.)

Development of the Chick Embryo. Color or B&W, 14 min., Coronet. (Carries the story through hatching.)

Development of Embryos. Filmstrip, Popular Science.

Development of Organs. Color or B&W, 28 min., MGH-AIBS Series. (Development of chick embryo.)

The Discovery of Insulin. B&W, 18 min., National Film Board of Canada and International Film Bureau. (Shows the work of Banting and Best.)

Endocrine Glands. B&W, 11 min., EBE. (Brief survey of the human endocrine system.)

Endocrine Glands—How They Affect You. B&W, 15 min., MGH. (Location and function of endocrine glands are explained through animation.)

The Flower and the Hive. Color, 11 min., National Film Board of Canada and International Film Bureau. (Role of bees in flower pollination; the bee dance.)

Flowers at Work (Second Edition). Color or B&W, 11 min., EBE. (Role of the flower in plant reproduction.)

From Generation to Generation. Color or B&W, 27 min., MGH. (Illustrates basic facts of human reproduction using animated and live sequences.)

Gymnosperms. Color or B&W, 17 min., EBE. (Life cycle of the pine.)

How Hormones Control the Body. Filmstrip, Popular Science.

Human Birth. Film Loop, BFA.

The Human Body: Reproductive System. Color or B&W, 13 min., Coronet. (Structure and function; the birth process.)

Human Reproduction (Second Edition). Color or B&W, 20 min., MGH. (Structure and function of male and female reproductive organs, fertilization process, development of fetus, and birth process.)

Human Reproduction and Birth. Film Loop Series, Ealing.

Life of a Plant. Color, 11 min., EBE.

The Living Mammal. Color, 17 min., International Film Bureau. (Defines mammals and shows various mammalian adaptations.)

Menstrual Cycle. Film Loop, BFA.

Pollen Tube Growth. Film Loop, Ealing.

Principles of Endocrine Activity. Color or B&W, 16 min., Indiana Univ. (General principles drawn from vertebrates, invertebrates, and plants.)

A Quarter Million Teenagers. Color, 16 min., Churchill. (On the physiological aspects of venereal diseases; designed specifically for teenage audiences.)

Reproduction Among Mammals. B&W, 11 min., EBE. (Uses the pig as an example, and makes comparisons with human beings.)

Reproduction in Animals. Color or B&W, 11 min., Coronet.

Reproduction in Plants. Color or B&W, 14 min., Coronet. (Asexual and sexual methods; selective breeding in plants. Elementary.)

Seed Dispersal. Color or B&W, 11 min., EBE.

Seed Germination. Color or B&W, 15 min., EBE. (Importance of seeds and plants to man.)

VD—Name Your Contacts. Color, 22 min., Coronet. (Shows attitudes and reactions of persons who have contracted VD.)

VD Questions, VD Answers. Color, 15 min., BFA. (Excellent.)

VD? See Your Doctor. Color, 22 min., Sterling. (Personal and community health aspects of VD.)

Venereal Disease and Your Health. Filmstrip, Society for Visual Education.

Venereal Disease: The Hidden Epidemic. Color, 25 min., EBE. (Excellent.)

DIRECTORY OF SCIENCE SUPPLY HOUSES

American Optical Corporation
Eggert & Sugar Rds.
Buffalo, New York 14215

Arbor Scientific Ltd.
Box 113
Port Credit, Ontario, Canada L5G 4L6

Bico Scientific Co.
55 East 25th St.
Chicago, Illinois 60616

Boreal Laboratories Ltd.
1820 Mattawa Ave.
Mississauga, Ontario, Canada

Canadian Laboratory Supplies
80 Jutland Road
Toronto, Ontario, Canada M82 2H4

Carolina Biological Supply Co.
Burlington, N.C. 27215
Powell Laboratories
Gladstone, Oregon 97027

Central Scientific Co.
2600 S. Kostner Ave.
Chicago, Illinois 60623

Coe-Palm Biological Supply House
1130 North Milwaukee Ave.
Chicago, Illinois 60622

Connecticut Valley Biological Supply Co.
Valley Road
Southampton, Massachusetts 01073

Fisher Scientific Co. E.D.M.
Materials Division
1259 N. Wood St.
Chicago, Illinois 60622

Graska Biological Supplies, Inc.
P.O. Box 2322
Oshkosh, Wis. 54901

Hach Chemical Co.
P.O. Box 907
Ames, Iowa 50010

Kemtec Educational Corp.
3514 Plyers Mill Road
Kensington, Md. 20795

Lab Aids Inc.
130 Wilbur Place
Bohemia, N. Y. 11716

LaMotte Chemical Products Co.
Educational Products Division
Chestertown, Maryland 21620

LaPine Scientific Co.
6001 South Knox Avenue
Chicago, Illinois 60629

Millipore Corporation
Ashby Road
Bedford, Massachusetts 01730

Mogul-Ed
P.O. Box 2482
Oshkosh, Wis. 54971

Nasco-Steinhilder Company
901 Janesville Avenue
Fort Atkinson, Wis. 53538
Nasco, West
1524 Princeton Avenue
Modesto, Calif. 95352
Arnold Nasco
Guelph, Ontario, Canada

Sargent-Welch Scientific Co.
7300 North Linder Avenue
Skokie, Illinois 60076
Branches in major cities

Science Kit, Inc.
777 E. Park Dr.
Tonawanda, New York 14150

Scientific Products Division
American Hospital Supply
1210 Waukegan Road
McGaw Park, Illinois 60085
Branches in major cities

Turtox/Cambosco
Macmillan Science Co., Inc.
8200 S. Hoyne Ave.
Chicago, Illinois 60620

VWR Scientific
P.O. Box 3200
San Francisco, Calif. 94119
Branches in major cities

Ward's Natural Science Establishment, Inc.
3000 East Ridge Road
Rochester, New York 14603
Branch: P.O. Box 1749
Monterey, California 93940

Western Seed Testing Service
439 Pierce Street
Twin Falls, Idaho 83301

Wilkens-Anderson Co.
4525 West Division Street
Chicago, Illinois 60651

DISTRIBUTORS OF AUDIOVISUAL MATERIALS

The following abbreviations are used in the audiovisual listings at the end of each unit of the *Teacher's Guide*. The unit listings contain various titles that were produced by companies which have gone out of business or have been absorbed by other firms, and which are therefore not included in the following directory. Out-of-print titles often continue to be available from AV libraries.

B&W—black and white
min.—minutes
BFA—BFA Educational Media
EBE—Encyclopaedia Britannica Educational Corp.
MGH—McGraw-Hill Films
Univ.—Universal Education and Visual Arts

American Cancer Society
7 East 52nd Street
New York, New York 10022
(Available from local Cancer Committees.)

American Heart Association
44 East 23rd Street
New York, N. Y. 10010
(Films available from state and local heart associations.)

American Telephone and Telegraph Co.
Public Relations Dept., Film Section
195 Broadway
New York, New York 10007
(Available from local telephone company.)

Arthur Barr Productions, Inc.
P.O. Box 5667
Pasadena, California 91107

Association—Sterling Films
600 Grand Ave.
Ridgefield, New Jersey 07657

Bausch & Lomb
Dept. 6606, Optics Center
1400 N. Goodman Street
Rochester, N. Y. 14602

BFA Educational Media
2211 Michigan Avenue, P.O. Box 1795
Santa Monica, California 90404

BSCS Single Topic Inquiry Films
Harcourt Brace Jovanovich, Inc.
757 Third Avenue
New York, New York 10017

Coronet Instructional Media
65 East South Water Street
Chicago, Illinois 60601

Denoyer-Geppert Audio-Visuals
355 Lexington Avenue
New York, N. Y. 10017
(Popular Science filmstrips.)

Walt Disney Educational Media Company
Glendale, California 91201

Educational Testing Service
20 Nassau Street
Princeton, New Jersey 08540

Encyclopaedia Britannica Educational Corp.
425 North Michigan Avenue
Chicago, Illinois 60611

Eye Gate House, Inc.
146-01 Archer Avenue
Jamaica, New York 11435

Harper & Row Media
10 East 53rd Street
New York, N. Y. 10022

Hubbard Scientific Co.
2855 Shermer Road
Northbrook, Illinois 60062

Indiana University Audio-Visual Center
Bloomington, Indiana 47405

International Film Bureau, Inc.
332 South Michigan Avenue
Chicago, Illinois 60604

McGraw-Hill
1221 Sixth Avenue
New York, N. Y. 10019

Metropolitan Life Insurance Company
Health and Welfare Division
One Madison Avenue
New York, N. Y. 10010

Modern Talking Picture Service, Inc.
2323 New Hyde Park Road
New Hyde Park, New York 11040

Moody Institute of Science
12000 E. Washington Blvd.
Whittier, Calif. 90606

National Film Board of Canada
P.O. Box 6100
Montreal 3, Canada
Also: Suite 819, 680 Fifth Avenue
New York, New York 10019
Suite 2320, 230 N. Michigan Avenue
Chicago, Illinois 60601

The New York Times/Arno Press
229 West 43rd St.
New York, New York 10036

Shell Oil Company Film Library
1433 Sadlier Circle, West Drive
Indianapolis, Ind. 46239

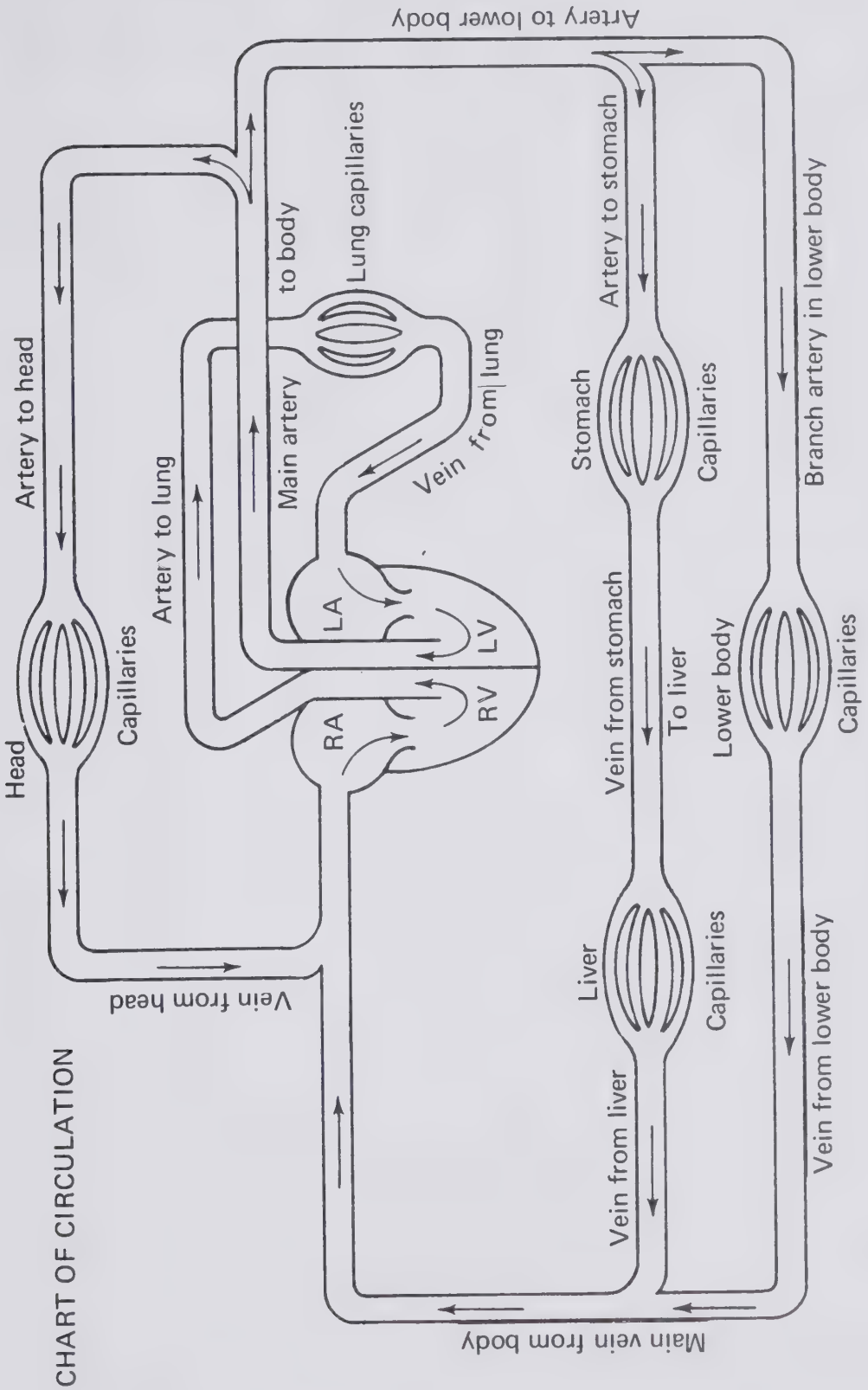
Society for Visual Education, Inc.
1345 Diversey Parkway
Chicago, Illinois 60614

Time-Life Multimedia
100 Eisenhower Drive
Paramus, N. J. 07652

U. S. Energy Research and Development Administration
Audio-Visual Branch
Division of Public Information
Washington, D. C. 20645

Universal Education and Visual Arts
221 Park Avenue South
New York, New York 10010

CHART OF CIRCULATION



URINALYSIS WORKSHEET

Test	*Results to Look For*	*Practice Urine*	*Mystery Practice Urine*
Color	Light yellow Medium yellow Dark yellow		
Appearance	Clear Cloudy		
Odor	Like urine Some other odor		
pH	Acid Basic Neutral		
Sugar	Blue None Green + Green-yellow ++ Yellow +++ Orange-red ++++		
Albumin	None Present		

ENVIRONMENT WORKSHEET

THE NEIGHBORHOOD

Businesses

___ offices
___ stores
___ factories
___ other (describe)

Public Buildings

___ library
___ church
___ health center
___ police or fire station
___ other (describe)

___ signs and billboards
___ markings on buildings
___ empty lots
___ damage to buildings
___ trash or litter (describe)

BUILDING MATERIALS OF THE CITY

Location or Use

___ brick or tile
___ stone
___ cement, concrete, stucco
___ wood
___ metal
___ glass
___ tar or blacktop
___ paint

TRAFFIC

Stand in one spot for 5 minutes.
Make a count of each of the following that you see:

___ people
___ cars
___ trucks
___ other (airplanes, motorcycles, etc.)

SOIL

Look at the bare ground nearest the school building. Describe it.

Take the temperature
___ 2 inches above ground ___ at the surface ___ 2 inches below ground.

Pour some water on the ground. Does the water sink in
___ quickly ___ slowly ___ not at all?

ANIMALS

Mammals

___ dogs
___ cats
___ squirrels
___ rats or mice
___ other (name)

Birds

___ sparrows
___ starlings
___ pigeons
___ gulls
___ robins
___ other (name)

Invertebrates

___ ants
___ caterpillars
___ roaches
___ flies
___ moths or butterflies
___ beetles
___ spiders
___ worms
___ other (name)

Animal Signs

___ droppings
___ feathers
___ nests
___ paw prints
___ other (describe)

PLANTS

Kinds of Plants

___ trees
___ shrubs
___ grass and herbs
___ mosses

Where Plants Grow

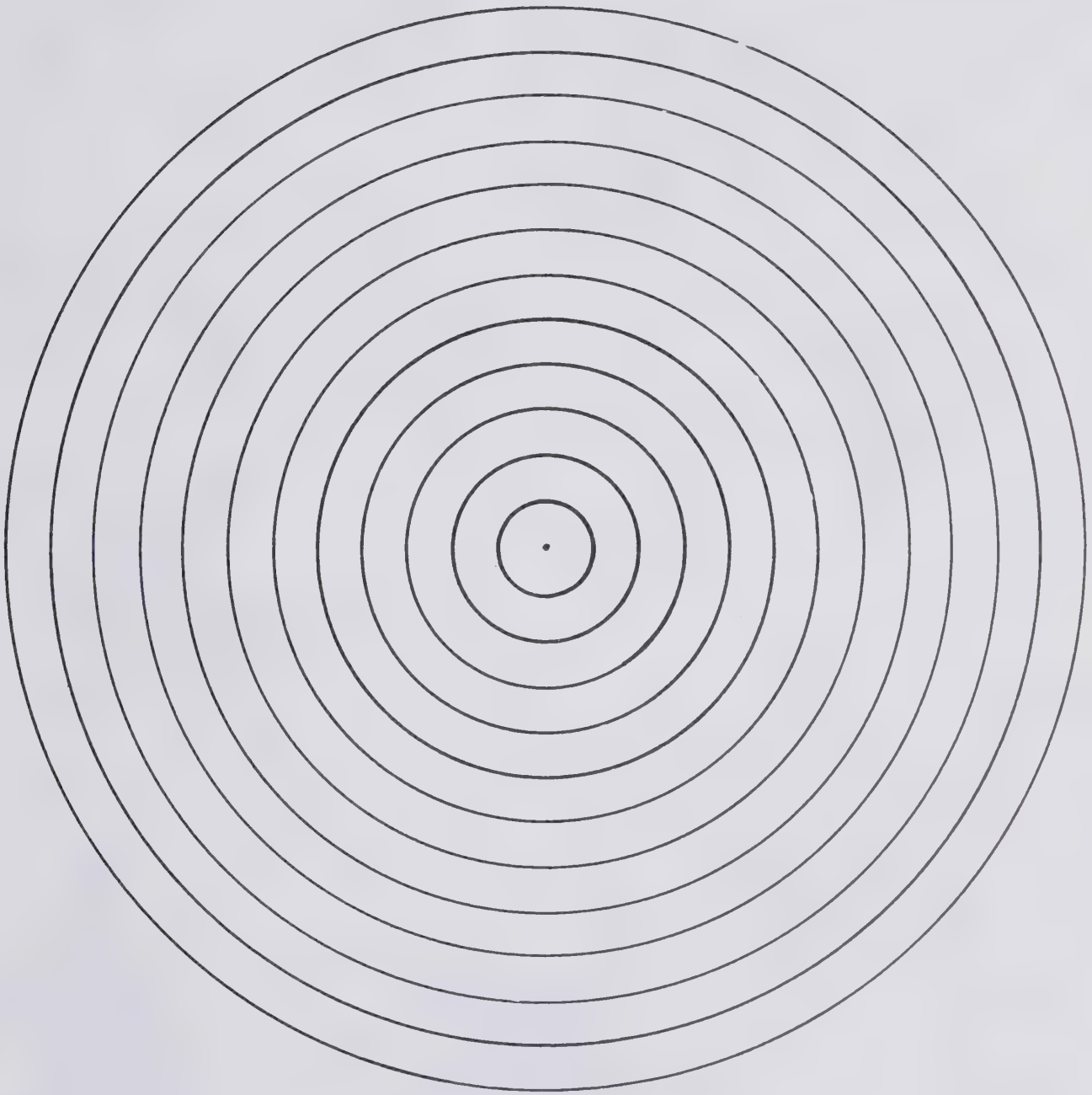
___ on the lawn
___ close to building
___ in sidewalk cracks
___ near the curb
___ around poles
___ in vacant lots
___ in the park
___ in peoples' yards
___ in window boxes
___ other (name)

WATER POLLUTION WORKSHEET

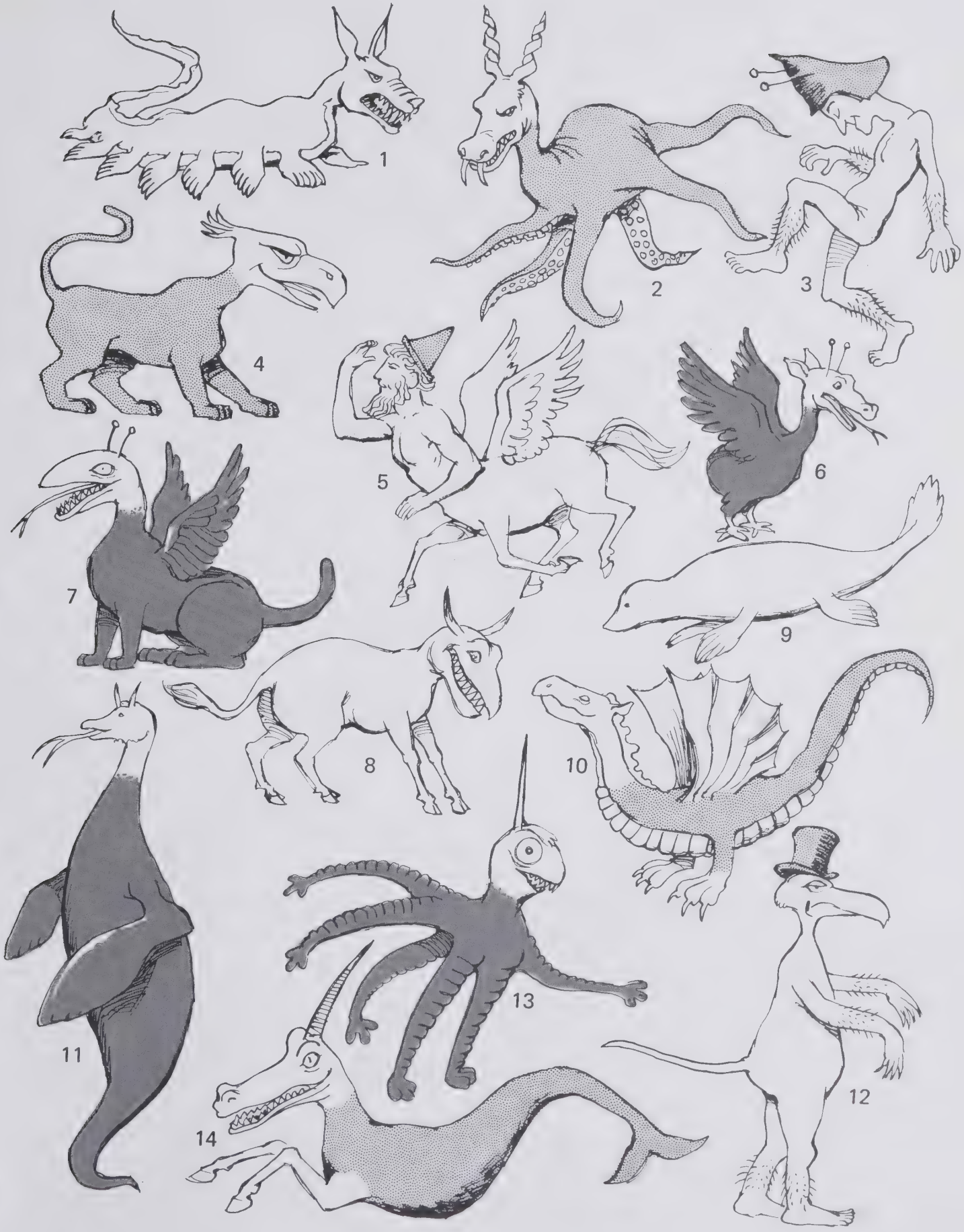
Test	*Results to Look for*	*Drinking Water*	*Lake Water*	*Sewage*
Color	Colorless Brownish Greenish Other (describe)			
Appearance	Clear Cloudy Other (describe)			
Odor	No odor Odor present (describe)			
Oil	No oil Oil present			
pH	Acid Basic Neutral			
Dissolved oxygen	No loss of blue color Some loss of blue color How long for blue color to disappear			
Detergent	No foam Foam present How long for foam to disappear			
Microscopic	No microbes Slight growth Heavy growth Draw typical microbes			
Filter	Describe appearance of filter paper Describe appearance of filtered water			

Your conclusion about the quality of the water. Give reasons for your conclusion.

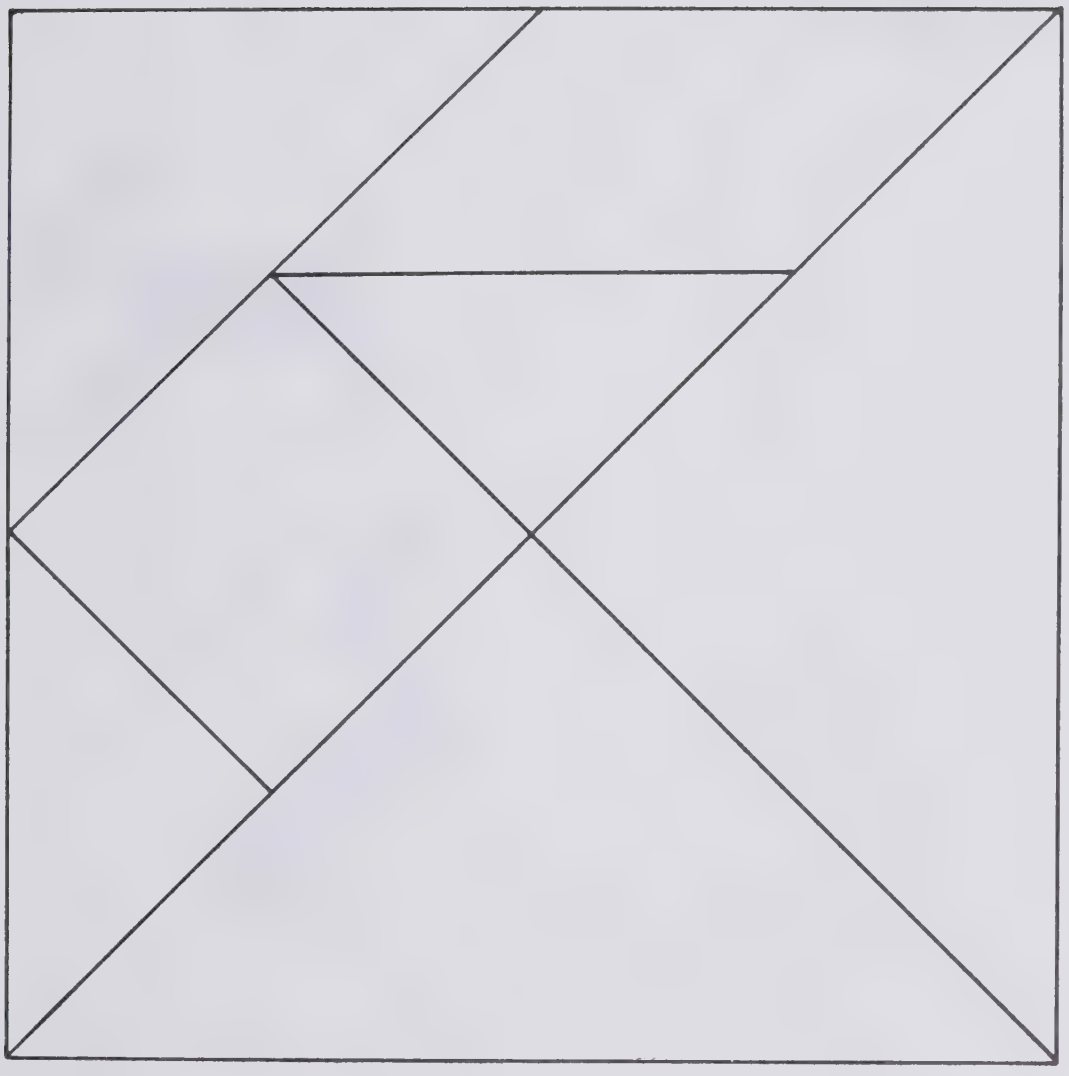
CONCENTRIC CIRCLES



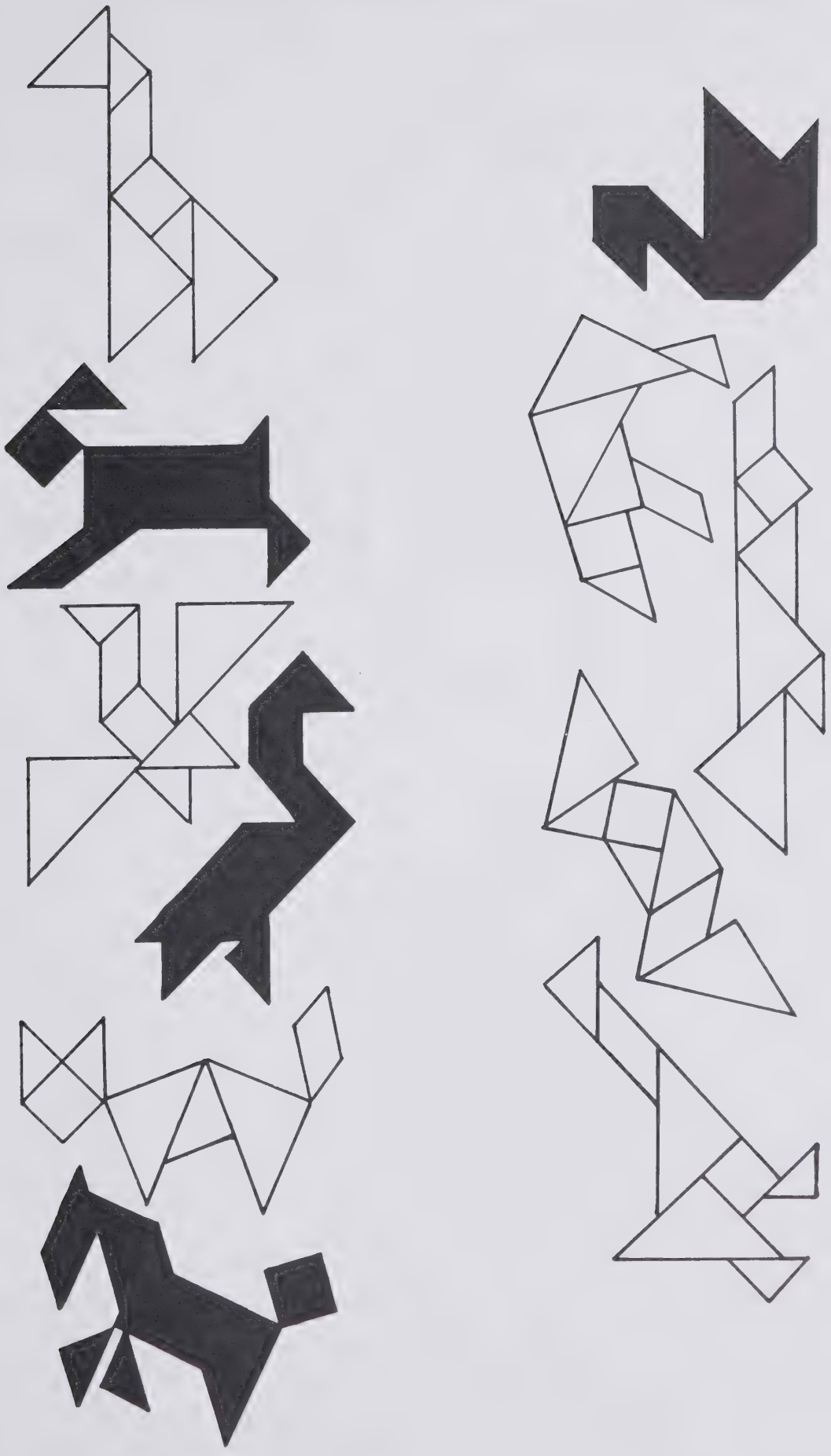
GROUPING WORKSHEET



TANGRAM WORKSHEET



TANGRAM WORKSHEET



FIELD WORKSHEET

Kind of Animal Observed _____ Number of Animals Observed _____

Place _____ Length of Time Observed _____

Date Observed _____

Kind of Behavior	*Comments*
Feeding	
Running or walking around	
Resting or sleeping	
Fighting, threatening, fleeing	
Courting or mating	
Getting or receiving care and attention	
Exploring, investigating, playing	
Imitating another animal	

TABLE OF GUESSES AND ACTUAL CARDS

	TEST 1		TEST 2		TEST 3		TEST 4		TEST 5	
	Guess	*Actual*	*Guess*	*Actual*	*Guess*	*Actual*	*Guess*	*Actual*	*Guess*	*Actual*
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
Score										

Total Score _____

Key: C = clubs D = diamonds H = hearts S = spades

HUMAN GENETICS WORKSHEET

Genetic Feature		*No. of* You	*No. of* Relatives		*No. of* You	*No. of* Relatives
1. Tasting PTC	taster	___	___	nontaster	___	___
2. Tongue-rolling	tongue-roller	___	___	non-tongue roller	___	___
3. Ear lobes	attached	___	___	free	___	___
4. Mongolian eye-folds	present	___	___	no folds	___	___
5. Dimples	present	___	___	no dimples	___	___
6. Freckles	present	___	___	no freckles	___	___
7. Hair whorl	clockwise	___	___	counterclockwise	___	___
8. Widow's peak	present	___	___	no widow's peak	___	___
9. Handedness	right-handed	___	___	left-handed	___	___
10. Shape of head	long	___	___	round	___	___
11. Height (for sex)	tall	___	___	short	___	___
12. Fingers very short or very long	very short or very long	___	___	average	___	___
13. Eye color	dark	___	___	blue	___	___
14. Nearsightedness	yes	___	___	no	___	___
15. Color blindness	yes	___	___	no	___	___
16. Complexion	dark	___	___	fair	___	___
17. Hair color	dark	___	___	blonde or red	___	___
18. White forelock	present	___	___	no white forelock	___	___
19. Hitchhiker's thumb	thumb bent	___	___	thumb straight	___	___
20. Folding hands	left thumb on top	___	___	right thumb on top	___	___
21. Shape of face	like yours	___	___	not like yours	___	___

REPRODUCTIVE SYSTEM WORD PUZZLE

Directions: Can you find hidden in the puzzle the words listed below? Words may run forward (left to right), down, or diagonally. Circle as many words from the list as you can find. One word is already circled.

1. circumcision
2. egg
3. ejaculation
4. foreskin
5. hormone
6. intercourse
7. male
8. marriage
9. parenthood
10. penis
11. prostate
12. reproduction
13. scrotum
14. semen
15. sperm
16. testes
17. tube
18. sex

A	M	A	L	E	T	I	S	E	X	F	T	J	Z	E	G	G	K
X	Z	Q	U	J	B	M	A	R	R	I	A	G	E	D	A	Q	C
H	S	O	B	A	R	J	S	S	U	R	P	R	I	S	E	M	Y
P	P	L	O	C	I	R	C	U	M	C	I	S	I	O	N	K	R
Y	E	V	F	U	Z	E	C	O	T	R	S	J	P	S	E	U	G
G	R	O	W	L	I	R	E	P	R	O	D	U	C	T	I	O	N
W	M	K	U	A	E	Y	A	A	O	D	B	D	A	C	B	P	X
N	L	Z	A	T	H	G	P	R	O	S	T	A	T	E	R	I	L
B	P	E	N	I	S	N	G	E	X	D	A	E	H	G	U	T	S
O	U	X	E	O	Q	X	I	N	T	E	R	C	O	U	R	S	E
O	M	M	K	N	S	B	W	T	R	S	O	Y	S	F	S	F	M
K	L	A	N	Y	J	E	R	H	O	R	M	O	N	E	I	U	E
S	C	R	O	T	U	M	D	O	I	Z	X	T	W	E	X	G	N
M	B	O	V	O	P	C	F	O	R	E	S	K	I	N	A	G	Y
C	T	E	S	T	E	S	W	D	N	V	G	H	T	U	B	E	M

ALPHABET CARDS

a	a	a	a	a	a	a	a	b	b	c	c	c	c	c	c
a	a	a	a	a	a	a	b	b	b	c	c	c	c	c	c
c	c	d	d	e	e	e	e	e	e	e	e	e	e	e	e
c	d	d	d	e	e	e	e	e	e	e	e	e	e	e	e
e	e	e	e	e	e	f	f	g	g	g	h	h	i	i	i
e	e	e	e	e	f	f	f	g	g	h	h	h	i	i	i
i	i	i	i	i	i	i	i	i	i	j	j	k	k	k	l
i	i	i	i	i	i	i	i	i	j	j	j	k	k	l	l
l	l	l	l	m	m	m	m	m	m	m	n	n	n	n	n
l	l	l	m	m	m	m	m	m	m	m	n	n	n	n	n
n	n	n	n	n	n	n	n	o	o	o	o	o	o	o	o
n	n	n	n	n	n	n	o	o	o	o	o	o	o	o	o
o	o	o	o	p	p	p	p	p	r	r	r	r	r	r	r
o	o	o	o	p	p	p	p	p	r	r	r	r	r	r	r
r	r	r	s	s	s	s	s	s	s	s	s	s	s	s	s
r	r	r	s	s	s	s	s	s	s	s	s	s	s	s	t
t	t	t	t	t	t	t	t	t	t	t	t	u	u	u	u
t	t	t	t	t	t	t	t	t	t	t	t	u	u	u	u
u	u	u	u	v	v	w	w	w	x	x	y	y	y	z	z
u	u	u	v	v	v	w	w	x	x	x	y	y	z	z	z

HORMONE BINGO WORKSHEET

Select 16 terms from the list below. Make a copy of the bingo card shown below and write one term in each square. When the teacher calls out a question, see if the answer is one of your terms. If it is place a marker on that square. Call out "BINGO!" when you have 4 markers in a line, straight across, up and down, or diagonal.

hormone
master gland
chemical messenger
testis
male sex hormone
female sex hormone
ovary
uterus
menstruation
the pill
birth control
insulin
thyroid hormone
family planning
ovulation
adolescence
adrenalin
adrenal gland
sex hormones
diabetes

"LET'S RAP" WORKSHEET

There are many important topics in sex and reproduction about which everyone has his own point of view. Opinions on some of these topics are given below. Mark *your* opinions in the "agree" and "disagree" columns. A committee will add up the results, and report to the class.

Meanwhile, your group should pick one or 2 of these topics for discussion. How do *you* feel about it?

You may give your conclusions to the class. See if they agree with you.

	Agree	*Disagree*
1. Sex should wait for marriage.		
2. Teenagers should not "pet."		
3. *Abortions* (uh·BOR·shuhnz) should be illegal.		
4. Teenage marriages are OK.		
5. Sex drive is strong in teenagers, so parents should keep an eye on them.		
6. There should be laws restricting *homosexuals* (hoh·moh·SEK·shoo·uhlz).		
7. Sex-centered ads are bad for society.		
8. "Dirty" books, magazines, and movies should be banned.		
9. Sex education should be taught in churches and in the home, but not in schools.		
10. Prostitutes should be jailed.		
11. Long engagements are a good idea.		
12. Unmarried people should not be allowed to live together.		
13. *Illegitimate* (il·luh·JIT·uh·muht) children must pay the penalty for their parents' misbehavior.		
14. It is all right for men to "play around," but not for women.		
15. *Masturbation* (mas·tur·BAY·shuhn) is bad for your health; it can even make you insane.		

Circle one: BOY GIRL

DATE DUE SLIP

DUE EDUC FEB 19'84	DUE EDUC MAR 07'88
FEB 19 RETURN	MAR 08 RETURN
DUE EDUC MAR 22'84	DUE EDUC AUG 10'88
DUE EDUC MAR 30'84 R	AUG 10 RETURN
MAR 29 RETURN	
DUE EDUC FEB 02'86	
EDUC FEB 09'86	
FEB 9 RETURN	
DUE EDUC FEB 16'86	
DUE EDUC MAR 05'86 R	
MAR 03 RETURN	
DUE EDUC OCT 12'86	
OCT 14 RETURN	
DUE EDUC FEB 14'88	
FEB 19 RETURN	

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